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## ABSTRACT

This paper examines the relationship between female schooling and two behaviors--cumulative fertility and contraceptive use--in 14 Sub-Saharan African countries where Demographic and Health Surveys (DHS) have been conducted since the mid-1980s. Using multivariate regression analysis, the paper compares the effect of schooling across countries, in urban and rural areas, and across different cohorts of women. The results show a negative correlation between female schooling and fertility in virtually all of the countries. Female primary schooling has a negative relation with fertility in about half of the countries and no relation in the other half. Secondary schooling is universally associated with lower fertility, and the strength of the effect increases with the years of schooling. Among ever-married women, husband's schooling has no significant relation with fertility in one-third of the countries and, when both women's and men's schooling matter, women's schooling exerts a much larger negative effect on fertility than men's schooling. Even low levels of female schooling are found to have a positive relationship with contraceptive use, but higher levels of schooling have a greater effect. Botswana, Kenya and Zimbabwe were found to have the highest levels of female schooling, lowest child mortality rates and the most vigorous family planning programs.  
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Living Standards  
Measurement Study  
Working Paper No. 110

## The Impact of Female Schooling on Fertility and Contraceptive Use

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(List continues on the inside back cover)

# **The Impact of Female Schooling on Fertility and Contraceptive Use**

**A Study of Fourteen Sub-Saharan Countries**

## The Living Standards Measurement Study

The Living Standards Measurement Study (LSMS) was established by the World Bank in 1980 to explore ways of improving the type and quality of household data collected by statistical offices in developing countries. Its goal is to foster increased use of household data as a basis for policy decisionmaking. Specifically, the LSMS is working to develop new methods to monitor progress in raising levels of living, to identify the consequences for households of past and proposed government policies, and to improve communications between survey statisticians, analysts, and policymakers.

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LSMS Working Paper  
Number 110

# **The Impact of Female Schooling on Fertility and Contraceptive Use**

**A Study of Fourteen Sub-Saharan Countries**

Martha Ainsworth  
Kathleen Beegle  
Andrew Nyamete

The World Bank  
Washington, D.C.

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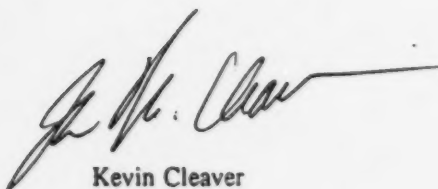
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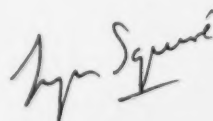
## Foreword

High fertility and the high demand for children in Sub-Saharan Africa are reflected in the rapid rate of population growth in the region, 3.2 percent per year. Recent demographic surveys reveal that women's "ideal family size" ranges from six to nine children, despite important advances in the provision of family planning and implementation of population policies in most countries. This paper examines the role of female schooling in determining levels of fertility and contraceptive use in fourteen Sub-Saharan countries with recent Demographic and Health Surveys, in an effort to point out another important component of population policy in the region. The levels of schooling of women of reproductive age in these countries are shockingly low — from fewer than two years to only six years. The results show that increasing female schooling will have an important impact in lowering fertility and raising contraceptive use in Sub-Saharan Africa, and they underscore the need for a broad, multifaceted population policy.

This paper is one of several products of the World Bank research project on "The Economic and Policy Determinants of Fertility in Sub-Saharan Africa", sponsored by the Poverty and Human Resources Division of the Africa Technical Department (AFTHR) and managed by Martha Ainsworth, principal investigator. It is part of a broader research effort in the Poverty and Human Resources Division of the Policy Research Department (PRDPH) that examines the role of human resources in economic development.



Kevin Cleaver  
Director  
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Director  
Policy Research Department

## Abstract

This paper examines the relationship between female schooling and two behaviors — cumulative fertility and contraceptive use — in fourteen Sub-Saharan African countries where Demographic and Health Surveys (DHS) have been conducted since the mid-1980s. Using multivariate regression analysis, the paper compares the effect of female schooling across countries, in urban and rural areas, and across different cohorts of women. For the subsample of ever-married women, the effect of female and male schooling is compared. By controlling for other background variables, such as age, area of residence, wealth, and ethnic and religious affiliations, the paper explores more precisely the effect of female schooling than can be obtained through two-way comparisons of schooling and fertility or contraceptive use.

The results show a negative correlation between female schooling and fertility in virtually all of the countries. However, the relationship is non-linear. Female primary schooling has a negative relation with fertility in about half of the countries and no relation in the other half. Secondary schooling is universally associated with lower fertility, and the strength of the effect increases with the years of schooling. No major differences between countries in different income groups is noted, but there is evidence of a positive relationship between income and fertility in Nigeria, and a negative relationship in Tanzania, Ghana, Togo and Botswana. Among ever-married women, husband's schooling has no significant relation with fertility in about one-third of the countries and, when both women's and men's schooling matter, women's schooling exerts a much larger negative effect on fertility than men's schooling.

Even low levels of female schooling are found to have a positive relationship with contraceptive use, but higher levels of schooling have a greater effect. Among ever-married women, husband's schooling is associated with higher contraceptive use in only six of the data sets and when significant, it generally exerts a smaller effect than does female schooling. Both in the case of fertility and of contraceptive use, there are large differences across countries that have not been explained. Two factors that could not be controlled for in the analysis are the availability of contraceptive services and levels of child mortality. The "success stories" in lowering fertility and raising contraceptive use are Botswana, Kenya and Zimbabwe, with the highest levels of female schooling, the lowest child mortality rates and the most vigorous family planning programs.

## Acknowledgments

This study was sponsored by the research project on the "Economic and Policy Determinants of Fertility in Sub-Saharan Africa", managed by the Poverty and Human Resources Division of the Policy Research Department (PRDPH) and sponsored by the Africa Technical Department of the World Bank (AFTHR). The authors are grateful to the World Bank Research Committee for financial assistance and to John Caldwell, Cynthia Cook, David Cornelius, Joy de Beyer, Barbara Herz, Cynthia Lloyd, Gora M'Boup, Amolo Ngwero, Lant Pritchett, Fred Sai, Guillerme Seladcek, Paul Shaw, Duncan Thomas, and Barbara Torrey for comments on earlier drafts. A special debt of gratitude is extended to Susmita Ghosh for assistance in completing the last draft. A preliminary version of this paper was presented at the annual meetings of the Population Association of America, May 1992. The opinions expressed in this paper are those of the authors and do not reflect official positions of the World Bank or its members.

## I. Introduction

Rapid population growth is exacerbating Africa's development problems and making it more difficult to raise average levels of welfare. Over the period 1980-88, the population of Sub-Saharan Africa grew at an unprecedented rate of 3.2 percent per year (World Bank, 1990). The continent's population has doubled since the 1960s and at its current rate of growth will double again in 22 years. Between 1965 and 1988, GNP per capita in the region grew by only 0.2 percent per year (World Bank, 1989b). During the 1980's GNP per capita actually *declined* by 2.6 percent per year. Rapid population growth coupled with slow growth in incomes is likely to raise the number of Africans in poverty by 100 million by the year 2000 (World Bank, 1990).

These projections highlight the urgent need to identify policies that will slow rapid population growth and raise the quality of life for Sub-Saharan countries. To date, twenty-seven countries have adopted or are considering adopting explicit policies to lower population growth (World Bank, 1989a). Contraceptive services are now offered in most public health systems as an integrated service with maternal and child health. Although most countries can make some inroads in raising contraceptive use through improving the availability, quality and targeting of services to women who want fewer children, there is also evidence that providing widespread contraception will not be sufficient to bring about a significant reduction in fertility, since the demand for children across the continent remains high. Even on the most recent demographic surveys, women's "ideal family size" ranges from six to nine children per woman (van de Walle and Foster, 1990). It is unlikely that provision of contraception alone will result in significant reductions in these figures.

This points to the need to develop a broader, multi-faceted strategy to lower the demand for children and raise contraceptive use. There is considerable debate in the literature as to whether high fertility and high desired family size in Africa are due to low levels of economic development that favor large families (see World Bank, 1984, 1986), or due to unique cultural features (see Caldwell and Caldwell, 1987, 1990). Without denying the possibility that cultural traits may contribute to higher demand for children in Africa than was the case in other developing regions, most studies *have* found differentials in current or total fertility by socioeconomic class, even in high fertility countries (see Cochrane and Farid, 1990 and United Nations 1987, for example). Among the factors thought to be the most conducive to the high demand for children are high child mortality and low levels of female schooling.

This paper examines empirically the relationship between female schooling and two behaviors — cumulative fertility and contraceptive use — in fourteen Sub-Saharan African countries where Demographic and Health Surveys were conducted in the mid-1980s to early 1990s. It takes the analysis of the impact of women's schooling one step beyond the two-way tabulations of levels of schooling and total fertility rates or contraceptive prevalence rates, by subjecting these data sets to multivariate regression analysis. This allows a more precise exploration of the relationship between women's schooling, fertility and contraceptive use, controlling for variables like age, area of residence, wealth, ethnic and religious affiliation. Further, results across the countries, for both national and sub-national samples, can be compared and form the basis for hypotheses on how to improve the effectiveness of women's schooling in lowering fertility in Sub-Saharan Africa. The three questions we hope to address are:

- What is the relationship between women's schooling and fertility, and women's schooling and contraceptive use in Sub-Saharan Africa?
- How do these relationships vary within and between countries?

- What might explain international differences in the effect of women's schooling within Africa?

The next section describes the posited relationship between women's schooling and fertility and presents the evidence to date on this relationship in Sub-Saharan Africa. Section 3 presents the empirical model that will be estimated and describes the data sets. Section 4 provides descriptive statistics — both from the data sets and from outside sources — on economic and demographic indicators for the fourteen countries under study. The fifth section describes the results for determinants of fertility and the sixth section for the determinants of contraceptive use. In concluding, the final section reviews the results and proposes areas for additional research.

## II. Women's schooling, fertility and contraceptive use

Women's schooling is posited to result in *lower* fertility and, by inference higher contraceptive use, through four main channels.

- **Wage effects.** Schooling raises the opportunity cost of women's time in rearing children, which raises the "price" of children (who are time-intensive) as well as the wage that women can earn in the workforce. The wage benefits of schooling may also induce women to get more schooling, thereby delaying the onset of childbearing. This is likely to result in lower fertility and higher female labor force participation rates.
- **Higher demand for child schooling.** Women with more schooling may develop higher aspirations for their own children's schooling. This may lead them to have fewer children and to invest in more schooling per child.<sup>1</sup>
- **Lower child mortality.** Women with more schooling are likely to be more effective in producing healthy children, resulting in lower child mortality. As the "wedge" between live births and surviving children is narrowed, couples find that they can have fewer children to reach a target number of surviving children.<sup>2</sup>
- **More effective use of contraception.** Educated women can learn about and use contraception more effectively than uneducated women, reducing the number of unanticipated pregnancies.

It has also been suggested that more schooling for women can indirectly *raise* fertility by improving maternal health, reducing pathological sterility and reducing the duration of breastfeeding and its contraceptive benefits (Alam and Casterline, 1984; Bongaarts et al, 1984; Casterline et al, 1984; Cochrane, 1979, 1988; Jejeeboy, 1992; World Bank, 1984)<sup>3</sup>.

There have been several studies of the differentials in aggregate measures of fertility between urban and rural areas and among women according to their level of schooling, using data from the World Fertility Survey (Alam and Casterline, 1984; Cochrane, 1988; Cochrane and Farid, 1990; United Nations, 1987). Table 1 presents differentials in the total fertility rate (TFR) by area of residence and women's education for African countries that participated in the more recent Demographic and Health Surveys (DHS). The TFR measured in these fourteen countries is very high — generally in the range of 6-7 children. However, in nearly every country the TFR is significantly lower in urban than in rural areas. One reason for these urban-rural differentials is the concentration of women with secondary and higher levels of schooling in urban areas. Women who have completed primary schooling or who have some secondary schooling universally have a lower TFR than women without schooling. The differential between the fertility of women with primary schooling and those

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1. This is the "quantity-quality" tradeoff observed in other parts of the world but examined only recently in Sub-Saharan Africa (see Montgomery and Kouamé, 1993; Oliver, 1994b; Kelley and Nobbe, 1990). There are, of course, many initiating factors for this tradeoff, including the levels of wages and employment expected of school-leavers and the quality and price of schooling available.

2. See Benefo and Schultz (1994) and Pitt (1994) for evidence of the relation between female schooling and child mortality in Sub-Saharan Africa. In a cross-national study, Schultz (1994) found that fully half of the effect of female schooling in lowering fertility was operating through its effect in lowering child mortality.

3. Female education is also thought to facilitate fertility decline by increasing the bargaining power of the wife, allowing greater control over her destiny, and improving husband-wife communication (Jejeeboy, 1992; United Nations, 1987).

with no schooling is smaller and sometimes in an unanticipated direction: results for Burundi, Cameroon, Kenya, Nigeria and Ondo State, Nigeria, indicate that women with some primary schooling actually have a *higher* TFR than those with no schooling.<sup>4</sup> Results such as these have cast doubt on the effectiveness of less-than-complete female primary schooling in lowering fertility, suggesting that schooling does not have a depressing effect on fertility until the secondary level (Cochrane, 1979, 1988; United Nations, 1987; World Bank, 1984). However, these patterns are not apparent in the relation between women's education and contraceptive use: in all African countries studied by the DHS, women with more years of schooling are also increasingly likely to be practicing contraception. In fact, even bivariate studies of the correlates of contraceptive use conducted in the 1960s found that use increased with levels of male and female education (see Cochrane 1979, Table 5.6).

The comparison of aggregate measures of fertility and contraceptive use by socioeconomic status is an interesting starting point for analysis, but has many shortcomings in terms of its usefulness for predicting the impact of policies. First, the two-way comparisons do not simultaneously control for other factors that influence fertility and contraceptive use. Income, for example, may be highly correlated with schooling but may have an opposite (positive) effect on fertility (Ainsworth, 1989, 1990; Farooq, 1985; NRC, 1993). Failure to control for these other correlated variables may confound the independent effects of schooling, other policy variables and exogenous factors like ethnicity. Second, the total fertility rate does not represent the completed fertility of any individual or cohort of women; rather, it is the number of children a woman *would* have over her reproductive lifetime *if* she were to bear children at prevailing age-specific fertility rates. Thus, cohort effects of schooling on the timing of births over the life cycle are not reflected in the comparisons of TFR for schooled and unschooled women. As a larger share of each cohort is educated, the relation between schooling and fertility for any given cohort is likely to change. Third, the policy objective is to lower aggregate measures of fertility by influencing *individual* decisions on the number of children. At the individual level, the policy objective is therefore to influence cumulative and completed fertility. Fourth and last, if there are any non-linearities in the relationship between policy variables and fertility, they will not necessarily be reflected in and cannot be studied with aggregates like the total fertility rate (Anker, 1985; Schultz, 1990). For these reasons, multivariate analysis of individual data may yield greater insights on the likely impact of policies such as female schooling on cumulative fertility.

The results of multivariate studies of economic determinants of fertility on individual data in Sub-Saharan Africa are summarized in Table 2. All of these studies explained variations in measures of cumulative fertility in terms of socioeconomic variables, controlling for the woman's age and sometimes her religion and ethnic group. Five studies focused on *the impact of women's schooling* and various proxies for *permanent income* — proxies such as the husband's schooling, husband's income, household consumption, land ownership and cattle. Women's schooling was associated with lower cumulative fertility in these studies; at low levels of schooling, the studies found either a significant negative impact of schooling (Ainsworth, 1989; Okojie, 1989, 1990; Snyder, 1974) or no impact (Anker and Knowles, 1982; Farooq, 1985). Two studies found a significant *positive* relation between primary schooling and fertility. Burafuta and Shapiro (1992) found that primary schooling was associated with higher fertility, while secondary schooling was associated with lower fertility in Burundi, relative to women with no schooling.<sup>5</sup> They were, however, unable to control for income. The study by Shapiro and Tambashe (1994) of women in Kinshasa, Zaire, found higher fertility

4. Note, however, that the TFR for those who exactly *completed* the primary cycle is substantially lower than for women with no schooling in all cases, including Kenya and Nigeria.

5. Both of the schooling coefficients were significant at only .10.

TABLE 1: Total Fertility rate, age 15-49, by residence and women's education  
African Demographic and Health Surveys

| Country                | Year    | Residence |       |                  | Women's Education |                      |                   |                      |
|------------------------|---------|-----------|-------|------------------|-------------------|----------------------|-------------------|----------------------|
|                        |         | All       | Urban | Rural            | None              | Primary <sup>a</sup> | Completed primary | More than primary    |
| Botswana               | 1988    | 5.0       | 4.1   | 5.4              | 6.0               | 5.2 <sup>b</sup>     | 4.6               | 3.3                  |
| Burundi                | 1987    | 6.8       | 5.3   | 6.9              | 6.8               | 7.2                  |                   | 5.5                  |
| Cameroon               | 1991    | 5.8       | 5.2   | 6.3              | 6.2               | 6.4                  |                   | 4.5                  |
| Ghana                  | 1988    | 6.4       | 5.1   | 6.6              | 6.8               | 6.1                  |                   | 5.9/3.6 <sup>d</sup> |
| Kenya                  | 1989    | 6.7       | 4.8   | 7.1              | 7.2               | 7.5 <sup>b</sup>     | 6.5               | 4.9                  |
| Mali                   | 1987    | 6.7       | 6.1   | 7.0              | 6.8               | 6.2                  |                   | n.a.                 |
| Niger                  | 1992    | 7.4       | 6.7   | 7.5              | 7.5               | 6.3 <sup>c</sup>     |                   |                      |
| Nigeria                | 1990    | 6.0       | 5.0   | 6.3              | 6.5               | 7.2 <sup>b</sup>     | 5.6               | 5.1/4.2 <sup>e</sup> |
| Ondo State,<br>Nigeria | 1986/87 | 6.0       | 5.9   | 6.0              | 6.7               | 7.1                  |                   | 5.4                  |
| Senegal                | 1986    | 6.6       | 5.5   | 7.1              | 6.8               | 5.7                  |                   | 3.8                  |
| Tanzania               | 1991/92 | 6.3       | 5.1   | 6.6 <sup>f</sup> | 6.5               | 6.4 <sup>b</sup>     | 6.0               | 4.2                  |
| Togo                   | 1988    | 6.6       | 4.7   | 7.0              | 6.8               | 5.7                  |                   | 4.5                  |
| Uganda                 | 1988/89 | 7.3       | 5.7   | 7.5              | 7.7               | 7.2 <sup>b</sup>     | 7.3               | 6.7/5.1 <sup>d</sup> |
| Zambia                 | 1992    | 6.5       | 5.8   | 7.1              | 7.1               | 6.8                  |                   | 4.9                  |
| Zimbabwe               | 1988    | 5.5       | 4.1   | 6.2              | 7.0               | 6.0                  |                   | 3.8                  |

a. In Botswana, Kenya, Tanzania, Uganda, Zambia, and Zimbabwe primary schooling includes 7 years of instruction. For all other countries this figure is 6 years; b. "Some primary"; c. First figure is for some secondary, second is for completed secondary and higher; d. First figure is for middle school, second is for higher; e. Any schooling (primary or more); f. Dar es Salaam TFR, 4.0, other urban mainland TFR, 5.6, Zanzibar TFR, 6.4; g. Mainland only.

Source: DHS country reports.

among women with primary schooling, but lower fertility among women with secondary schooling relative to those with no schooling, while controlling for "economic status". It is often hypothesized that higher fertility among women with primary schooling, which is sometimes observed, is due to shortened breastfeeding intervals. However, the authors also found that primary and lower secondary schooling were *not* associated with shortened breastfeeding in this sample, relative to women with no schooling (see below). Fairlamb and Nieuwoudt (1991) found a large and significant negative effect of the years of female schooling on children ever born, but the results were confounded by endogenous regressors and had no control for exogenous income. Finally, a study of the progression to first birth in Togo and Uganda found that seven or more years of schooling reduces the progression to first birth in both countries.<sup>6</sup>

6. The United Nations (1987) study of twelve African countries in the WFS found a negative relation between schooling and fertility for women with ten or more years of schooling and who had been married for at least three years. For levels of schooling less than ten years, the relationship was cited as positive. However, the statistical significance of the coefficients on lower years is not reported and female schooling was significant in only five to six of the countries. Husband's schooling at all levels has a positive relation with fertility, and was significant in only six of the countries.

*Urban residence* is associated with lower fertility in all but one of the studies (Burafuta and Shapiro, 1992), in which urban residence had no association with fertility. *Husband's education* had a positive relation with cumulative fertility in three studies that did not have any other measures of income (Okojie, 1989, 1990; Snyder, 1974; United Nations, 1987) but a negative relation when women's education and a proxy for household permanent income were controlled for (Ainsworth, 1989). Five studies found a positive relation between child mortality and fertility (Ahn and Shariff, 1992; Anker, 1985; Farooq, 1985; Okojie, 1990; Snyder, 1974). Only two studies attempted to examine the impact of the *availability of health services*, but in both cases no significant impact on fertility was observed (Okojie, 1989, 1990). Finally, Snyder (1974) examined the tradeoff between the number of children and *school investments* and found, counterintuitively, that couples with larger families also had more schooling.

There have been fewer multivariate studies of the economic determinants of contraceptive use in Sub-Saharan Africa at the individual level.<sup>7</sup> Njogu (1991) compared the determinants of contraceptive use over time in Kenya, using data from the 1977-78 Kenya Fertility Survey and the 1989 Kenya Demographic and Health Survey. Women with education at all levels were significantly more likely to use contraception compared with women with no education, and the impact of education rises with the level. An unpublished study of contraceptive use in Ouagadougou found similar positive effects of women's literacy and schooling on ever-use of modern contraception (Fenn et al, 1987). Shapiro and Tambashe (1994) found that all levels of schooling, including primary schooling, significantly raise the probability of contraception among a sample of non-pregnant women in Kinshasa, Zaire. Similar results were found for a sample of all women of reproductive age in Burundi (Burafuta and Shapiro, 1992). Multivariate studies in other regions have found that women's education has a uniformly direct relation with contraceptive use and that husband's education also has a direct but less powerful relation (Cochrane, 1979). Guilkey and Cochrane (1993) find that the presence of a community-based distributor (CBD) and the number of educational opportunities in the community are associated with higher use in Zimbabwe. Thomas and Maluccio (1994) show the evidence that the presence of a CBD mainly affects use among more-educated women, while the characteristics of the CBD and indicators of service quality mainly affect contraceptive use among less educated women.

The multivariate studies suggest a negative but nonlinear relation between women's schooling and fertility and demonstrate the potentially confounding effects of other variables correlated with schooling (such as household income) in interpreting the results. However, the studies are less than conclusive. First, several had serious methodological problems that could invalidate the results, the most worrisome of which is the inclusion of potentially endogenous regressors in analysis of fertility — variables such as the age at first birth, childspacing intervals, child schooling and women's labor force participation (Snyder, 1974); contraceptive use, breastfeeding, child survival and the desired level of child schooling (Anker and Knowles, 1982); age at marriage (United Nations, 1987). In multivariate analysis of contraceptive use, endogenous regressors have included: children ever born, women's labor force participation, current enrollment status (Burafuta and Shapiro, 1992; Shapiro and Tambashe, 1994); marital status (Fairlamb and Nieuwoudt, 1991; Fenn et al, 1987; Shapiro and Tambashe, 1994); and stated fertility intentions (Fairlamb and Nieuwoudt, 1991; Njogu, 1991; Shapiro and Tambashe, 1994). Second, most of the studies used a sample of currently married women. By conditioning on marriage, they have not captured the full effect of socioeconomic variables on fertility (through delayed marriage) or contraceptive use (out of wedlock) and, since

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7. The NRC (1993) study conducted a multivariate analysis of the determinants of contraceptive use in sixty-eight regions of Sub-Saharan Africa using mean completed female schooling, urban residence, the percent of women in polygamous unions and the percent of women who practiced moslem and traditional religions. The results confirmed the very strong effect of female schooling relative to other factors.

marriage and childbearing could be thought of as a joint decision, have introduced a potential sample selection bias in favor of women with higher demand for children.<sup>8</sup> Finally, each study used different specifications and samples that make cross-country comparisons difficult.

The present study seeks to avoid many of these methodological pitfalls by using a common set of exogenous regressors on samples of all women, regardless of marital status. Further, by examining similar specifications across data from fourteen countries, the study enhances the cross-country comparability of results using the most up-to-date data sources available.

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8. Snyder (1974) and Chernichovsky (1985) studied an even more selective sample — women with children. Shapiro and Tambashe (1994) study contraceptive use in a sample of non-pregnant women. United Nations (1987) studies marital fertility in a group of women married for at least three years.

TABLE 2 SUMMARY OF MULTIVARIATE ANALYSES OF ECONOMIC DETERMINANTS OF FERTILITY AND CONTRACEPTIVE USE IN SUB-SAHARAN AFRICA

| Author                             | Study Date | Country and Survey                                                          | Sample Size | Dependent Variable                                      | Explanatory Variables and Relationships                                                                                                                                                                                                                                                                                 | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------|------------|-----------------------------------------------------------------------------|-------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ECONOMIC DETERMINANTS OF FERTILITY |            |                                                                             |             |                                                         |                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Snyder*                            | 1974       | Sierra Leone (1966-68 Western Area Household Survey, Freetown and vicinity) | 717         | Number of live births fathered by the head of household | Mother's education (negative)<br>Father's education (positive)<br>Wife's wage (not significant)<br>Actual child mortality (positive)<br>Child "quality" (positive)                                                                                                                                                      | Controlled for wife's age, wife's age at first birth, ethnic group, moslem religion, husband's and wife's occupation. Examined relationships for cohorts of women. OLS estimation. Sample of households with currently married, male monogamous heads. Many specifications had endogenous regressors (child quality, women's labor force participation, child mortality, birth intervals, age at first birth)                                                                                                           |
| Anker and Knowles*                 | 1982       | Kenya (1974 ILO/University of Nairobi Household Survey)                     | 1,888       | Children ever born                                      | Mother's education:<br>0-4 years (not significant)<br>> 4 years (negative)<br>Husband's education (positive)<br>Land owned (positive)<br>Urban residence (negative)                                                                                                                                                     | Endogenous regressors (women's labor force history, use of family planning, migrant status, polygamous union, duration of breastfeeding, child survival rates in the household, desired level of schooling for children)<br>Sample of household with currently married woman 15-49.                                                                                                                                                                                                                                     |
| Anker*                             | 1985       | Kenya (same as above)                                                       | 1,170       | Children ever born                                      | Mother's education (continuous variable) (negative)<br>Husband's education (positive/ns)<br>Household income (neg for urban)<br>Child mortality (positive)<br>Land owned (positive)                                                                                                                                     | Experiments with nonlinear specifications of woman's age and schooling. Separate estimates for all women, urban, rural and in four tribes. Same problem with endogenous regressors as Anker and Knowles (above).                                                                                                                                                                                                                                                                                                        |
| Chernichovsky                      | 1985       | Botswana (1974-75 Rural Income Distribution Survey)                         | 858         | Children ever born                                      | Women's functional literacy (negative)<br>Value of livestock (positive)<br>Value of land (positive)                                                                                                                                                                                                                     | Some endogenous regressors (age at first birth, presence of husband, type of household). Sample is of mothers 15 and older with at least one live birth.                                                                                                                                                                                                                                                                                                                                                                |
| Farooq*                            | 1985       | Southwest Nigeria (1971 Fertility, Family and Family Planning Survey)       | 3,400       | Children ever born                                      | 1. Urban sample:<br>Mother's education standards 1-12 (not significant) higher (negative)<br>Husband's income (positive)<br>Child mortality (positive)<br>2. Rural sample:<br>Mother's education standards 1-3 (positive)<br>standards 4-9 (not significant)<br>standards 10 + (negative)<br>Child mortality (positive) | OLS regressions, sample of currently married women under 50. Regressions for three age cohorts separately within urban and rural areas. Muslim religion had negative coefficient in rural areas. Income left out of rural regressions, which possibly accounts of positive coefficient on early female education. Endogenous regressors: breastfeeding; age at marriage; attitude, knowledge and practice of contraception; women's labor force participation. Controlled for age, age squared. No community variables. |

| Author                                        | Study Date | Country and Survey                                         | Sample Size  | Dependent Variable                                                 | Explanatory Variables and Relationships                                                                                                                                       | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------|------------|------------------------------------------------------------|--------------|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| United Nations<br>(Africa results, Table 124) | 1987       | 12 African countries, WFS                                  | not reported | Children ever born divided by marital duration, multiplied by 1000 | Women's schooling<br>10 years and more (negative)*<br>Fewer than 10 years (positive)*<br>Husband's schooling<br>All levels (positive)                                         | Sample of ever married women 15-49 who had been married at least 3 years. Controlled for age at marriage, marital duration, marital duration squared, urban residence, childhood residence. Female education was significant in only 5-6 countries. No mention is made whether schooling coefficients for lower levels (1-3, 4-6, 7-9 years) were statistically significant. Results presented as unweighted averages of regression coefficients by region; cannot tell whether insignificant coefficients were included in the average. No controls for income, except perhaps husband's education. |
| Ainsworth                                     | 1989, 1990 | Cote d'Ivoire (1985 Cote d'Ivoire Living Standards Survey) | 1,444        | Children ever born                                                 | Women's schooling (negative)<br>Primary years (negative)<br>Secondary years (negative)<br>Household consumption/adult (positive)<br>Urban residence (negative)                | Controlled for age, age squared, ethnic group, region of residence. Estimates by age group and for urban and rural women. When economic variables controlled for, ethnic variables barely significant. Estimated by OLS, tobit and Poisson models; results robust to choice of model; consumption variable passed exogeneity test. Sample of all women 15 and older.                                                                                                                                                                                                                                 |
| Okojie                                        | 1990       | Bendel State, Nigeria                                      | 1,814        | Children ever born                                                 | Women's schooling:<br>Primary (negative)<br>Secondary (negative)<br>Higher (negative)<br>Husband's schooling (positive)<br>Presence of modern hospital (not significant)      | Controlled for age, age squared, ethnic group, husband's occupation. OLS estimates by cohort and for urban and rural areas. Sample of ever-married women.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Okojie                                        | 1989       | Bendel State, Nigeria                                      | 1,895        | Children ever born                                                 | Women's schooling (negative)<br>Husband's schooling (positive)<br>Presence of modern hospital (not significant)<br>Predicted child mortality (positive)                       | Controlled for age, age squared, husband's occupation. Estimates by cohort and for urban and rural areas. Child survival ratio was predicted using instrumental variables technique. Wu-Hausman test found child survival ratio was endogenous.                                                                                                                                                                                                                                                                                                                                                      |
| Fairlamb and Nieuwoudt                        | 1991       | KwaZulu, Natal South Africa (1988 survey)                  | 175          | Living children                                                    | Women's schooling (negative)<br>Desired family size * dummy for currently married (positive)<br>Index of chores in which children involved * common law wife dummy (positive) | Controlled for age, age squared, age*common law wife. Sample was from three strata each within one urban and one rural area: professional women; semi-skilled not formally employed. OLS regressions. Endogenous regressors: desired family size; child labor contributions; marital status.                                                                                                                                                                                                                                                                                                         |
| Burafuta and Shapiro                          | 1992       | Burundi (1987 DHS)                                         | 3970         | Children ever born                                                 | Women's schooling:<br>Primary (positive)<br>Secondary (negative)<br>Urban residence (not significant)                                                                         | Controlled for age, age squared, regions. OLS estimate of reduced form model. Other specifications with endogenous regressors showed that coefficient on women's education is extremely sensitive to inclusion of endogenous regressors, such as women's force participation and child mortality. Sample of all women, regardless of marital status.                                                                                                                                                                                                                                                 |

continued on next page

TABLE 2 *continued*

| Author               | Study Date | Country and Survey                       | Sample Size           | Dependent Variable                    | Explanatory Variables and Relationships                                                                                                                                                                                                                                                                                                                                                                                                                               | Comments                                                                                                                                                                                                                                                                                                               |
|----------------------|------------|------------------------------------------|-----------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ahn and Shariff      | 1992       | Togo (1988 DHS) and Uganda (1988/89 DHS) | 3360 (T)              | Progression to first birth (women)    | Women's schooling:<br>1-3 yrs (negative, Togo)<br>4-6 yrs (not significant)<br>7-9 yrs (negative, both)<br>10+ yrs (negative, both)<br>Own radio (negative, both)<br>Cement floor (not significant)<br>Community infant mortality rate (not significant)<br>Community child mortality rate (positive, Uganda)<br>Urban residence (negative, Togo)                                                                                                                     | Hazard estimation of age at first birth. Controlled for woman's age, regions of country. Other community-level variables included share of children with tetanus injection (positive in Togo), share of births with trained attendant (negative in Togo, positive in Uganda) prevalence of diarrhea (not significant). |
|                      |            |                                          | 9861 (T)<br>14387 (U) | Hazard of subsequent birth (children) | Women's schooling<br>1 yr, 3 yr (not significant)<br>2 yr (negative, Uganda)<br>4 yr, 5 yr, 6 yr, 7+ yr (negative, Togo)<br>Husband's schooling<br>1-3 yr (negative, Togo)<br>4-7 yr, 7+ yr (positive, Uganda)<br>Mortality of previous child (positive)<br>Own radio (positive)<br>Woman currently working (negative, Uganda)<br>Urban residence (negative)<br>Community infant mortality rate (positive, Togo)<br>Community child mortality rate (negative, Uganda) |                                                                                                                                                                                                                                                                                                                        |
| Guilkey and Cochrane | 1993       | Zimbabwe (1988 DHS)                      | 2,050                 | Children ever born                    | Women's schooling<br>4-6 years (not significant)<br>7+ years (negative)<br>Husband's schooling (negative)<br>Urban residence (negative)<br>Commune (negative)<br>Commercial farm (negative)<br>ZNFPCC clinic within 5 km at age 15 (negative)<br>Presence of hospital, clinic or mission clinic within 5 km at age 15 (not significant)                                                                                                                               | Controlled for age, christian, no control income. Sample of currently married, non-pregnant, non-sterilized women 15-45. Endogenous placement of ZNFPCC clinics a potential problem.                                                                                                                                   |

| Author               | Study Date | Country and Survey                          | Sample Size | Dependent Variable | Explanatory Variables and Relationships                                                                                                                                                                                                                                                     | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------|------------|---------------------------------------------|-------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Thomas and Maluccio  | 1994       | Zimbabwe (1988 DHS, Situation analysis)     | 4201        | Children ever born | <u>Reduced form model:</u><br>Women's schooling<br>6 years and higher<br>(negative, for young women)<br>Car (negative)<br>Husband's education<br>10 years or more<br>(negative, for young women)<br>Bike, radio, TV, cattle, goats/sheep<br>(not significant)<br>Rural residence (positive) | Controls for age, marital status, ethnicity, sample of all women 15-49.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                      |            |                                             |             |                    | <u>Structural model:</u><br>Current use (not significant, except positive for women 15-19)<br>Ever use (not significant, except positive for women 15-19)                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                      |            |                                             |             |                    | Births in past 5 years<br>Current use (not significant, except positive for women 15-19, 20-29)<br>Ever use (same)                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                      |            |                                             |             |                    | Birth in last year<br>Current use (not significant)<br>Ever use (not significant)                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                      |            |                                             |             | Children ever born | Women's schooling<br>primary (positive)<br>secondary (negative)<br>Employment status<br>employee (negative)<br>Economic index<br>(negative)                                                                                                                                                 | Instruments for contraceptive use are availability and quality of CBDS and availability of family planning in local clinics.                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                      |            |                                             |             |                    |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                      |            |                                             |             |                    |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                      |            |                                             |             |                    |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                      |            |                                             |             |                    |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                      |            |                                             |             |                    |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Shapiro and Tambashe | 1994       | Kinshasa, Zaire (Authors' household survey) | 2372        | Children ever born |                                                                                                                                                                                                                                                                                             | Sample of women 13-49, stratified by economic and employment status of women. One-third of women are employed in formal sector, compared to only 4 percent in the population of Kinshasa. Controls for age, age squared, religion and ethnic group. Specifications with and without endogenous regressors (employment status, migration status, marital status), and for sample of all women and women not currently enrolled in school. In accompanying regressions, primary and lower secondary schooling are not associated with reduced breastfeeding. |
|                      |            |                                             |             |                    |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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TABLE 2 *continued*

| Author                                     | Study Date | Country and Survey                           | Sample Size            | Dependent Variable                                           | Explanatory Variables and Relationships                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------|------------|----------------------------------------------|------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DETERMINANTS OF CONTRACEPTIVE USE          |            |                                              |                        |                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| United Nations (Africa results, Table 126) | 1987       | 12 African countries **                      | not reported           | Current use of contraception                                 | Women's schooling<br>All levels (positive)<br>significant in 11 countries                                                                                                                                                                                                                                                                                                                                                                                                                                          | Sample of ever married women 15-49 who had been married for at least 3 years. Controls included area of residence, age at marriage, marital duration, and duration squared. Results are reported as unweighted averages of regression coefficients for the group. Individual country results not shown, and significance of lower levels of schooling not discussed.                                                                                                                                   |
| Fenn, McGinn and Charbit                   | 1987       | Ouagadougou, Burkina Faso<br>1986 KAP survey | 730                    | Ever-use of modern contraception                             | Mother's education<br>Primary (not significant)<br>Secondary (positive)<br>Mother's literacy (positive)                                                                                                                                                                                                                                                                                                                                                                                                            | Sample of ever-married women 15-49. 65 percent were unschooled and 9 percent had ever used a modern method. Controlled for ethnic group, maternal age marital status, childhood residence and current neighborhood. Logit and OLS. The collinearity of literacy and mother's education probably reduced the effect of primary education. Authors also performed regression of CEB; however, endogenous proximate determinants were included on the right hand side and were not properly instrumented. |
| Njogu*                                     | 1991       | Kenya<br>(1977-78 WFS,<br>1989 DHS)          | 4171 (WFS)<br>4075 DHS | Current use of modern method                                 | Mother's education<br>Primary (positive)<br>Secondary (positive)<br>Child mortality (negative, 1977)                                                                                                                                                                                                                                                                                                                                                                                                               | Sample of currently married, fecund, non-pregnant women. The (endogenous) desire for additional children was included as a regressor in contraceptive use regression, likely to bias coefficient on education and child mortality. Level of impact of women's education on contraceptive use has diminished over the time between the two surveys.                                                                                                                                                     |
| Burafuta and Shapiro                       | 1992       | Burundi<br>(1987 DHS)                        | 3970                   | Current use of modern or traditional method                  | Women's schooling:<br>Primary (positive)<br>Secondary (positive)<br>Urban residence (positive)                                                                                                                                                                                                                                                                                                                                                                                                                     | OLS regression of sample of all women of reproductive age. Controls for age and region of the country. Endogenous regressors included children ever born and dummy variables for female employment. Dependent variables included both modern and traditional methods because fewer than 1 percent were using a modern method.                                                                                                                                                                          |
| Guilkey and Cochrane                       | 1993       | Zimbabwe                                     | 2050                   | Current method<br>Choice:<br>modern,<br>traditional,<br>none | Wife's education 4-6 (positive for modern and traditional vs. none)<br>Wife's education 7+ (not significant)<br>Husband's education (not significant)<br>Husband absent (negative for traditional vs. none)<br>Urban residence (negative for traditional vs. none)<br>Assets (not significant)<br>Land ownership (not significant)<br>Number of schools in community (positive for modern and traditional vs. none)<br>Presence of CBD in community (positive for modern vs. none)<br>FP message (not significant) | Sample of currently married, non-pregnant, non-sterilized women                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Author               | Study Date | Country and Survey                          | Sample Size | Dependent Variable             | Explanatory Variables and Relationships                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------|------------|---------------------------------------------|-------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Thomas and Maluccio  | 1994       | Zimbabwe (1988 DHS, Situation analysis)     | 4201        | Current use of a modern method | Women's schooling<br>Years 1-3 (not significant)<br>Years 4-6 (positive, 4%)<br>Years 7-8 (positive, 7%)<br>Years 9-11 (positive, 8%)<br>Years 12+ (positive, 15%)<br>Husband's schooling (positive at high levels)<br>Bike/motorbike (positive)<br>TV (positive)<br>Goats/sheep (negative)<br>Cattle (not significant)<br>Car, radio (not significant)<br>Rural residence (not significant)<br>General hospital within 30 km (positive, rural, younger, less educated)<br>Mobile FP clinic (positive, older women, and less educated)<br>CBD (positive for younger women more educated, urban)<br>CBD has bike (positive)<br>Nearest clinic has needles (positive)<br>Nearest clinic has traditional methods (negative)<br>Number of nurses at nearest clinic (positive) | Controls for age, marital status, ethnicity, sample of all women 15-49. Female education significant only at very high levels of schooling for women > 34 and TV is only significant asset. Education effects are smaller in rural areas and no step at end of primary. Large step at end of primary in urban areas. Service characteristics that were not significant: rural hospital within 30 km, hospital or clinic has electricity, equipment, and training of CBD, clinic has IAP kit, distributes condoms, depo provera, other methods, price of pills, distance to facilities, doctor present. |
| Shapiro and Tambashe | 1994       | Kinshasa, Zaire (Authors' household survey) | 1856        | Current use of a modern method | Women's schooling (positive, all levels)<br>Employment status<br>self-employed (negative)<br>employee (negative)<br>non-employee (positive)<br>Economic status (positive)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Sample of non-pregnant, ever-sexually active women 13-49, stratified by economic and employment status of women. Controls for age, age squared, religion and ethnic group. Endogenous regressors include employment status, enrollment status, marital status, children ever born and fertility desires. Separate regression for all (modern and traditional) methods found employees and self-employed are more likely than non-employed women to use any method.                                                                                                                                     |

\* Denotes published material.

\*\* Cote d'Ivoire, Senegal, Benin, Ghana, Sudan, Tunisia, Morocco, Egypt, Lesotho, Mauritania, Kenya, Cameroon.

### III. Empirical model and data sets

The empirical model for analysis of fertility regresses a measure of cumulative fertility — children ever born to each woman — on a set of independent variables that are assumed to be exogenous to fertility decisions but that influence either the demand for or supply of children. This reduced-form model of fertility "determinants" can be written as:

$$y = \beta_0 + \beta_1 x_1 + \beta_{12} x_1^2 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \mu$$

where:

- y is the dependent variable, children ever born
- $\beta_0$  is an intercept
- $x_1$  is the woman's age, entered in quadratic form to control for biological factors affecting the supply of births
- $x_2$  is the woman's schooling, in various specifications
- $x_3$  is a dummy variable for urban residence
- $x_4$  is the woman's ethnic group
- $x_5$  is the woman's region of residence
- $x_6$  is the woman's religion
- $x_7$  is a group of variables proxying the household's income or wealth

The empirical models for contraceptive use are identical, except for the dependent variables, which are dichotomous (dummy) variables indicating current use or ever use of modern contraception.

In order to examine in more detail the non-linearities of schooling effects, the results from four different specifications of schooling are presented: (1) years of completed schooling as a linear term; (2) years of completed schooling in quadratic form (schooling and schooling squared); (3) dummy variables for the level of schooling reached — primary (1-6 or 7 years), lower secondary (7-10 or 8-10 years) and higher levels (11 and more years); and (4) dummy variables for individual years of completed schooling.<sup>9</sup> Relationships for the national sample as well as for the following sub-samples are presented: urban women, rural women, and women aged 15-24, 25-34 and 35-49.

The choice of independent regressors has been influenced by the availability of information in the data sets to be used. The analysis uses data from fourteen Sub-Saharan African countries collected by the Demographic and Health Surveys in the late 1980s and early 1990s. The DHS samples are large — from 3000 to 9000 women aged 15-49. Large sample size is important because in many countries only a small proportion of women have had any schooling (fewer than a third of women in Burundi, Mali and Senegal, for example). There are, unfortunately, no measures of household income or consumption in the DHS data sets. We use instead four variables that serve as proxies for income and wealth: whether or not the household owned a radio, tv or bicycle, and the quality of housing. The latter is a dichotomous variable that indicates whether the floor of the household's residence is either cement, tile, polished wood or parquet; the default categories are mud, sand and/or clay in most countries.

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9. In six countries, the primary cycle is completed in seven years (Tanzania, Uganda, Kenya, Zambia, Zimbabwe, Botswana). In these instances, the "level of schooling" variables are set equal to primary (1-7 years), secondary (8-10 years) and higher (11 and more years). Cameroon has a dual system, with those in the Francophone areas completing primary in six years, and those in the Anglophone areas completing primary in seven years. The primary school variable used in Cameroon is set to reflect incomplete or complete primary schooling for whichever system the woman was enrolled in.

There are a few econometric issues relevant to estimation of the empirical model of fertility determinants, concerning censoring of the data. First, the value of the dependent variable — children ever born — is censored from below at zero. It can take on only zero or positive integer values. Under these conditions, least squares regression coefficients are inconsistent and, when the dependent variable and regressors are normally distributed, are biased *downward* in proportion to the degree of censoring in the sample (Greene, 1981). Depending on the data set, roughly a quarter of the women in the samples (ranging from 16 percent in Mali to 30 percent in Burundi) have had no live births. The censoring will be most extreme in the analysis of the youngest cohort (15-24) and urban women, and least extreme in analysis of older and rural women.

The censoring of children ever born can be dealt with directly in selecting the econometric model used. The Tobit model, for example, takes into account the censoring of the dependent variable at zero, although not its integer nature. A Poisson count model takes into account both the censoring and integer nature of the dependent variable and, with appropriate estimation of the standard errors, the coefficients would be unbiased, even if the mean and variance of the dependent variable are not equal (as is implied by this model). Experience in estimating OLS, Tobit and Poisson models on the determinants of fertility in Côte d'Ivoire revealed that: (1) the Tobit and Poisson models generated very similar results in terms of the magnitude and significance of coefficients; and (2) that for all sub-samples except young women and possibly urban women, Tobit and Poisson models produced results identical in sign and significance and very similar in magnitude to ordinary least squares coefficients (Ainsworth, 1989). Thus, we have opted to use the simpler and easy-to-interpret OLS technique for the fertility regressions. This censoring problem does not arise for the contraceptive use regressions. In that case, the dependent variable is dichotomous (0/1). Maximum likelihood logit is used in estimation of the parameters (Maddala, 1983).<sup>10</sup>

The second censoring issue involves the fact that we include in the analysis women who have not completed their fertility. One way of dealing with this problem would be to predict the completed fertility of younger women based on the determinants of fertility found among women who had already completed or nearly completed childbearing. However, in most African countries this would restrict the analysis to an older sample of women (over 40 or even older) that has had very little schooling. Further, we anticipate that the relation between schooling (as well as other independent variables) and fertility may be changing over time, as the aggregate proportion of schooled women increases, the quality and price of schooling change, family planning becomes more widely available to younger women and other socioeconomic conditions (such as income) evolve. To account for the fact that women in the samples have been exposed to the risk of pregnancy for differing amounts of time and for the fact that fecundity over the 15-49 age range rises with age, peaks and then declines, we control for the woman's age and age squared.

A third censoring issue of unknown magnitude, relevant to both the fertility and contraceptive use regressions, is the possibility that some of the women in the sample — particularly those 15-19 — may not have completed their schooling. The DHS data sets did not record whether the women in the sample were currently enrolled in school. However, given the limited amount of schooling in all of the national samples at the primary and especially the secondary level, we do not anticipate that upper censoring of the completed schooling variable is a major problem in this analysis.

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10. Standard errors in both the fertility and contraceptive use regressions are corrected for heteroskedasticity and cluster effects.

#### IV. Descriptive statistics for the fourteen sub-Saharan countries

The fourteen sub-Saharan countries included in this study span the continent in terms of their geographic location, colonial heritage and level of economic development (see Table 3). Half of the countries are West African (Cameroon, Ghana, Niger, Nigeria, Mali, Senegal and Togo), four are in Eastern and Central Africa (Burundi, Kenya, Tanzania and Uganda) and three are in Southern Africa (Botswana, Zambia and Zimbabwe). Six countries are French-speaking (Burundi, Cameroon, Mali, Niger, Senegal, Togo); the other eight are English-speaking. They range in size from Botswana, with slightly more than one million people, to Nigeria, with a population of 90 million or more. Most of these countries have very low incomes; seven had incomes per capita of less than US\$400 in 1991.<sup>11</sup> Among the twelve countries for which data are available, eight had *negative* rates of growth of GNP/capita in the 1980's, and for two others GNP/capita grew at less than one percent per year. There are wide divergences in female enrollment and infant mortality rates. As recently as 1990, for example, female primary enrollments represented only 17 percent of primary-aged girls in Mali, 21

TABLE 3: Economic and Social Indicators, DHS Countries

| COUNTRY  | GNP/<br>capita<br>1991 | Growth rate<br>in GNP/<br>capita<br>1980-91 | Population<br>in millions<br>mid-1991 | Percent<br>urban | Population<br>growth<br>rate<br>1980-91 | Infant<br>mortality<br>rate<br>1991 | Female<br>GPER <sup>a</sup><br>1990 | Female<br>GSER <sup>b</sup><br>1990 |
|----------|------------------------|---------------------------------------------|---------------------------------------|------------------|-----------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Tanzania | 100                    | -0.8                                        | 25.2                                  | 34               | 3.0                                     | 115                                 | 63                                  | 4                                   |
| Uganda   | 170                    | ..                                          | 16.9                                  | 11               | 2.5                                     | 118                                 | ..                                  | ..                                  |
| Burundi  | 210                    | 1.3                                         | 5.7                                   | 6                | 2.9                                     | 107                                 | 64                                  | 4                                   |
| Mali     | 280                    | -0.1                                        | 8.7                                   | 20               | 2.6                                     | 161                                 | 17                                  | 4                                   |
| Niger    | 300                    | -4.1                                        | 7.9                                   | 20               | 3.3                                     | 126                                 | 21                                  | 4                                   |
| Nigeria  | 340                    | -2.3                                        | 99.0                                  | 36               | 3.0                                     | 85                                  | 63                                  | 17                                  |
| Kenya    | 340                    | 0.3                                         | 25.0                                  | 24               | 3.8                                     | 67                                  | 92                                  | 19                                  |
| Ghana    | 400                    | -0.3                                        | 15.3                                  | 33               | 3.2                                     | 83                                  | 67                                  | 31                                  |
| Togo     | 410                    | -1.3                                        | 3.8                                   | 26               | 3.4                                     | 87                                  | 80                                  | 10                                  |
| Zambia   | .. <sup>c</sup>        | ..                                          | 8.3                                   | 51               | 3.6                                     | 106                                 | 91                                  | 14                                  |
| Zimbabwe | 650                    | -0.2                                        | 10.1                                  | 28               | 3.4                                     | 48                                  | 116                                 | 46                                  |
| Senegal  | 720                    | 0.1                                         | 7.6                                   | 39               | 3.0                                     | 81                                  | 49                                  | 11                                  |
| Cameroon | 850                    | -1.0                                        | 11.9                                  | 42               | 2.8                                     | 64                                  | 93                                  | 21                                  |
| Botswana | 2530                   | 5.6                                         | 1.3                                   | 29               | 3.5                                     | 36                                  | 112                                 | 47                                  |

Notes: a. Gross primary enrollment ratio b. Gross secondary enrollment ratio c. 1990 GNP/capita was \$420.

Source: World Bank, 1993, (World Development Report 1993).

11. To facilitate comparisons across countries at different levels of development and the possible role of relative incomes in the results, country estimates are presented in order of increasing 1991 GNP per capita.

percent in Niger and only half of the primary-aged girls in Senegal.<sup>12</sup> By comparison, the inclusion of over-aged girls in primary enrollments in Botswana and Zimbabwe raised their gross female primary enrollment rates to over 100 percent. In only three countries — Ghana, Zimbabwe and Botswana — do female secondary enrollments equal or exceed 30 percent of the women in that age group. Perhaps not coincidentally, Zimbabwe and Botswana are two of the three African countries where demographers believe that an aggregate fertility decline is underway (van de Walle and Foster, 1990). Infant mortality rates (IMR) also show great variation. Botswana and Zimbabwe have IMRs lower than 50 per thousand, while six countries have rates greater than 100/1000 (Tanzania, Uganda, Burundi, Mali, Niger, Zambia). Despite these differences in economic and social indicators, levels of fertility and population growth rates in the fourteen countries are high and remarkably similar. With the exception of Burundi, Cameroon, Mali and Uganda, population growth rates were between 3 and 4 percent per year during the 1980s. Recall from Table 1 that the total fertility rates in all but Botswana, Cameroon and Zimbabwe were between 6.0 and 7.4 children per woman.

The fifteen DHS data sets, the year of data collection and sample characteristics are presented in Table 4.<sup>13</sup> Of the fifteen data sets, only five are nationally self-weighted samples and achieved total coverage (Ghana, Ondo State Nigeria, Senegal, Togo, Zimbabwe). Thus, these sample statistics may differ from statistics from a self-weighted random sample of women.<sup>14</sup> The average woman in the DHS country samples was 27 to 29 years old and, with the exception of Botswana and Zimbabwe, had three or more live births. Except for Kenya, Zimbabwe and Botswana, fewer than 10 percent of the sampled women were using a modern method of contraception. Levels of urbanization in the samples were highest in Botswana, Cameroon, Mali, Niger, Nigeria, Senegal and Zambia, where 40 percent or more of sampled women were living in urban areas.<sup>15</sup>

Levels of schooling among the women of reproductive age in these samples are very low. The gross primary and secondary enrollment rates for these countries, which are low, nevertheless reflect higher levels of instruction at present than was the case for the women 15-49 in the DHS data sets. The highest levels of schooling of all of the African DHS datasets is observed in Zimbabwe, where the average woman in the sample had completed only 6 years and where 13.6 percent of the sample had received no formal schooling. In the other African DHS data sets, levels of schooling are far lower. In Senegal, Mali, Niger and Burundi, for example, mean schooling for the sample was less than 2 years and roughly three-quarters or more of the women had received no schooling. And since the DHS over-sampled urban women in Mali, Niger and Burundi, these statistics *overstate* the true levels of education at the national level.

Figure 1 presents the distribution of schooling across women in all national samples according to the years of completed schooling. Beginning in the first row of Figure 1, countries are presented in order of increasing GNP per capita. Note in particular the very large share of women in all countries who have had no schooling, even in countries with higher per capita incomes, like Senegal. In fact, the French-speaking and Sahelian countries have by far the lowest schooling of women of reproductive age. But even in Ghana and Nigeria, thought to have strong educational policies in the

12. The most recent figure for Uganda (1988) also indicates a female gross primary enrollment ratio of 50 percent.

13. There are two DHS data sets for Nigeria: one conducted for Ondo State in 1986-87 and a national survey in 1990. Thus, this paper considers 15 data sets from fourteen countries.

14. See Annex 1 for a description of the sample design and coverage of the 15 surveys.

15. In Botswana, Cameroon, Mali, Niger and Nigeria, urban women were over-sampled. National levels of urbanization are reported in Table 3 above.

TABLE 4: DHS sample statistics, 15 sub-Saharan data sets

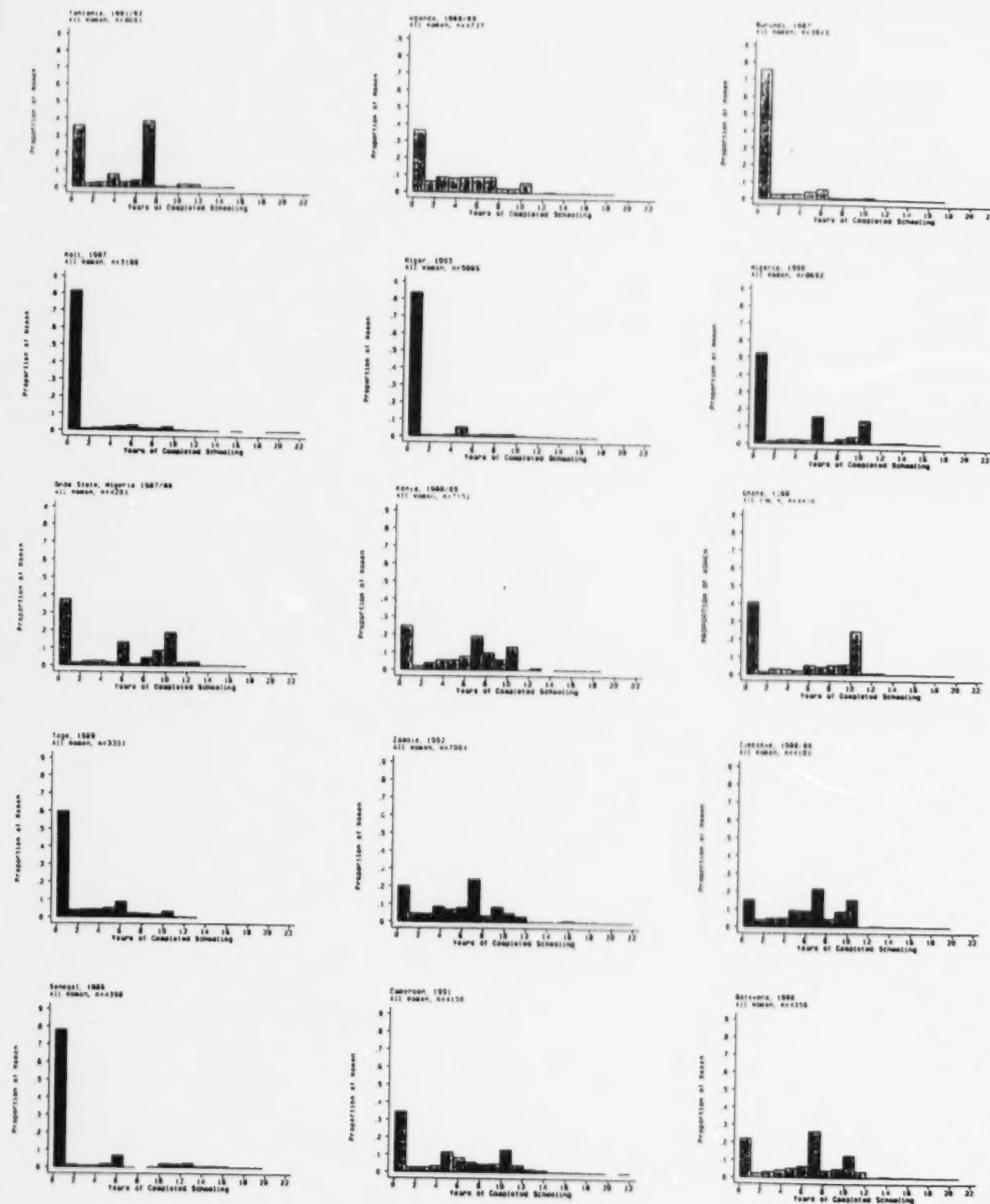
| Country             | Year    | Sample Size | FERTILITY | CONTRACEPTIVE USE (%)     |                        | AGE      |                      |       |      | URBAN         | WOMEN'S SCHOOLING    |                              |                   |                   |      |
|---------------------|---------|-------------|-----------|---------------------------|------------------------|----------|----------------------|-------|------|---------------|----------------------|------------------------------|-------------------|-------------------|------|
|                     |         |             | Mean CEB  | Current use modern method | Ever use modern method | Mean age | Age distribution (%) |       |      | Percent urban | Mean years schooling | Dist'n of women by schooling |                   |                   |      |
|                     |         |             |           |                           |                        |          | 15-24                | 25-34 | 35 + |               |                      | 0                            | 1-6               | 7-10              | 11 + |
| Tanzania            | 1991-92 | 9001        | 3.15      | 5.2                       | 12.6                   | 27.9     | 44.1                 | 29.3  | 26.6 | 20.0          | 4.16                 | 35.2                         | 59.0 <sup>a</sup> | 2.4 <sup>b</sup>  | 3.4  |
| Uganda              | 1988-89 | 4727        | 3.40      | 3.4                       | 9.6                    | 27.1     | 46.1                 | 31.2  | 22.6 | 20.4          | 3.67                 | 34.5                         | 52.7 <sup>a</sup> | 7.5 <sup>b</sup>  | 5.3  |
| Burundi             | 1987    | 3943        | 3.00      | 2.3                       | 4.2                    | 28.4     | 38.5                 | 35.8  | 25.7 | 15.9          | 1.37                 | 74.2                         | 20.6              | 3.7               | 1.6  |
| Mali                | 1987    | 3188        | 3.83      | 2                         | 5.1                    | 29.3     | 34.3                 | 35.7  | 30.0 | 41.9          | 1.22                 | 80.5                         | 12.0              | 5.9               | 1.7  |
| Niger               | 1992    | 6255        | 3.72      | 5.0                       | 9.4                    | 27.8     | 40.1                 | 34.3  | 25.6 | 41.3          | 1.10                 | 82.0                         | 11.1              | 5.7               | 1.2  |
| Nigeria             | 1990    | 8692        | 3.20      | 4.9                       | 11.5                   | 28.2     | 38.3                 | 34.7  | 27.1 | 40.1          | 3.71                 | 51.9                         | 24.0              | 10.5              | 13.7 |
| Ondo State, Nigeria | 1986-87 | 4201        | 3.31      | 5.8                       | 10.8                   | 28.8     | 39.8                 | 26.3  | 34.0 | 40.2          | 5.11                 | 36.9                         | 23.9              | 22.3              | 17.0 |
| Kenya               | 1988-89 | 7102        | 3.53      | 15.4                      | 26                     | 28.2     | 40.2                 | 33.2  | 26.7 | 26.8          | 5.45                 | 24.0                         | 45.6 <sup>a</sup> | 18.7 <sup>b</sup> | 11.7 |
| Ghana               | 1988    | 4470        | 3.17      | 4.7                       | 20.4                   | 28.6     | 38.2                 | 33.7  | 28.1 | 34.0          | 4.91                 | 39.8                         | 16.2              | 38.7              | 5.3  |
| Togo                | 1989    | 3351        | 3.21      | 3.4                       | 10.7                   | 28.1     | 41.2                 | 32.8  | 26.1 | 35.2          | 2.31                 | 58.8                         | 29.2              | 10.4              | 1.6  |
| Zambia              | 1992    | 7004        | 3.13      | 6.7                       | 22.1                   | 26.9     | 48.2                 | 29.8  | 22.1 | 47.6          | 5.37                 | 18.4                         | 59.8 <sup>a</sup> | 16.4 <sup>b</sup> | 5.4  |
| Zimbabwe            | 1988-89 | 4179        | 2.96      | 27.2                      | 48.4                   | 27.8     | 44.3                 | 30.8  | 25.5 | 33.3          | 6.04                 | 13.6                         | 55.9 <sup>a</sup> | 16.6 <sup>b</sup> | 13.9 |
| Senegal             | 1986    | 4398        | 3.27      | 2.7                       | 6.2                    | 27.7     | 42.3                 | 33.8  | 23.8 | 41.0          | 1.78                 | 77.5                         | 13.3              | 1.2               | 8.0  |
| Cameroon            | 1991    | 3871        | 2.99      | 5.4                       | 19.9                   | 27.4     | 44.9                 | 31.0  | 24.2 | 56.5          | 5.06                 | 33.4                         | 29.5 <sup>a</sup> | 24.5 <sup>a</sup> | 12.7 |
| Botswana            | 1988    | 4356        | 2.44      | 31.8                      | 56.8                   | 27.4     | 43.4                 | 34.9  | 21.7 | 51.7          | 5.85                 | 20.8                         | 50.3 <sup>a</sup> | 21.6 <sup>b</sup> | 7.3  |

a. Includes 1-7 years of primary schooling. b. Includes 8-10 years of schooling. c. In Cameroon, part of the country adheres to a six-year primary school cycle and another part adheres to a seven-year cycle. The primary category includes all who attended part or all primary grades, regardless of the systems, and the secondary category represents 7-10 years or 8-10 years of schooling, depending on which system the woman attended.

past, 40 and 50 percent of all women in these samples, respectively, have had no schooling. In Tanzania, once thought to have achieved universal primary education, about 35 percent of women never attended school. Of course, Figure 1 lumps together women of many different age cohorts. The distribution of women by schooling in each country, urban and rural subsamples, and by cohort is presented in Annex 2. Examining the figures in Annex 2 across age cohorts shows substantive progress in female schooling among younger women in many countries — Botswana, Cameroon, Ghana, Kenya, Ondo State (Nigeria), Tanzania, Zimbabwe, and Zambia. However, in other countries there has been little or no change in level of education over time.

Another point worth noting in Figure 1 is that the distribution of schooling among educated women is uneven in a number of countries. In Ghana, for example, about 43 percent of women had no schooling and about 25 percent had exactly 10 years. In Botswana, 21 percent had no schooling and 27 percent had exactly 7 years. In Tanzania, 35 percent of women had no schooling, while 40 percent had exactly 7 years. In Kenya, Nigeria and Zimbabwe, "spikes" are observed in the distribution at 7 years of schooling in all samples and at 11 years for urban women (see Annex 2). The "lumpiness" of the distribution of schooling in some of these data sets — including the relative scarcity of observations with less than complete primary schooling — is important to consider in interpreting the regression results. While the mean level of schooling may be 2 to 3 years, very few women are commonly found with exactly that number.

Figure 1. Distribution of women 15-49 by years of completed schooling



## V. Women's schooling and fertility

### National samples

The ordinary least squares (OLS) regression results for three of the four specifications in the fourteen countries are pictured in Figure 2, which plots the predicted children ever born for women according to their level of schooling, while controlling for their age, area of residence, ethnicity, religion, ownership of durable goods and quality of housing. The straight line in each graph represents the linear specification of schooling, where the slope is constrained to be constant, regardless of the level of schooling. In all of the countries, the linear specification is sloped downward, showing that increased schooling is generally associated with lower fertility. However, there are important differences in the "steepness" of the linear regression lines. In Tanzania, Uganda, Burundi, Mali, Niger, Togo, and Senegal, they are relatively "flat", showing only slight decreases in fertility with increased education.

The curved dotted lines represent the predictions from a quadratic specification of schooling, in which fertility is expressed as a function of the woman's schooling and the square of her schooling. The individual circles represent the results of allowing a dummy variable for each individual year of schooling. Both of these specifications allow for non-linearities in the relation between female schooling and fertility. What these specifications show is that at low levels of schooling there is either no relation or a weak negative relation between female schooling and fertility, but that with the completion of primary schooling the negative relationship strengthens. This makes sense, since it is difficult to believe that less than full primary schooling could result in basic literacy and numeracy or could substantially alter the opportunity costs of women's time. Also recall the distribution of women by amount of schooling in Figure 1, which showed that most women fall in the "no schooling" category or the complete primary schooling category; some of the dummy variables for individual years of schooling represent very few women and are not individually statistically significant. In fact, given how few women obtained higher levels of schooling in the Sahelian countries, for example, one must view with skepticism the curves for very high schooling levels.

Table 5 presents some of these results numerically. The first column shows OLS regression coefficients for the linear specification, which used the highest year of schooling completed by the female respondent as the regressor. These coefficients can be interpreted as the effect on the number of children ever born of increasing female schooling by one year and represent the slopes of the straight lines in Figure 2. The second through fourth columns are the OLS regression coefficients for a fourth specification not shown in Figure 2, which used dummy (dichotomous) variables representing three different levels of schooling — 1-6 years, 7-10 years and 11 and more years.<sup>16</sup> The coefficients on levels of schooling are interpreted as the effect on the number of children ever born of raising women's education from zero to that level. All other explanatory variables (age, age squared, urban residence, region, ethnicity, religion, ownership of durable goods and quality of housing) were also entered in the regressions when available<sup>17</sup> and are, therefore, controlled for. Unless otherwise

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16. For countries with a seven-year primary cycle, the levels entered are 1-7 years and 8-10 years. The coefficients on this specification for "levels" of schooling capture the non-linearities in Figure 2, but are easier to interpret than the coefficients on the quadratic and individual years of schooling specifications.

17. The following data sets did not have the full set of independent variables: ethnic group was missing for Botswana, Burundi, Cameroon, Nigeria, Ondo State (Nigeria), Tanzania, Uganda, and Zambia; region was missing for Botswana and Ondo State (Nigeria); religion was missing for Burundi.

Figure 2. Predicted cumulative fertility according to the level of female schooling  
(three specifications)

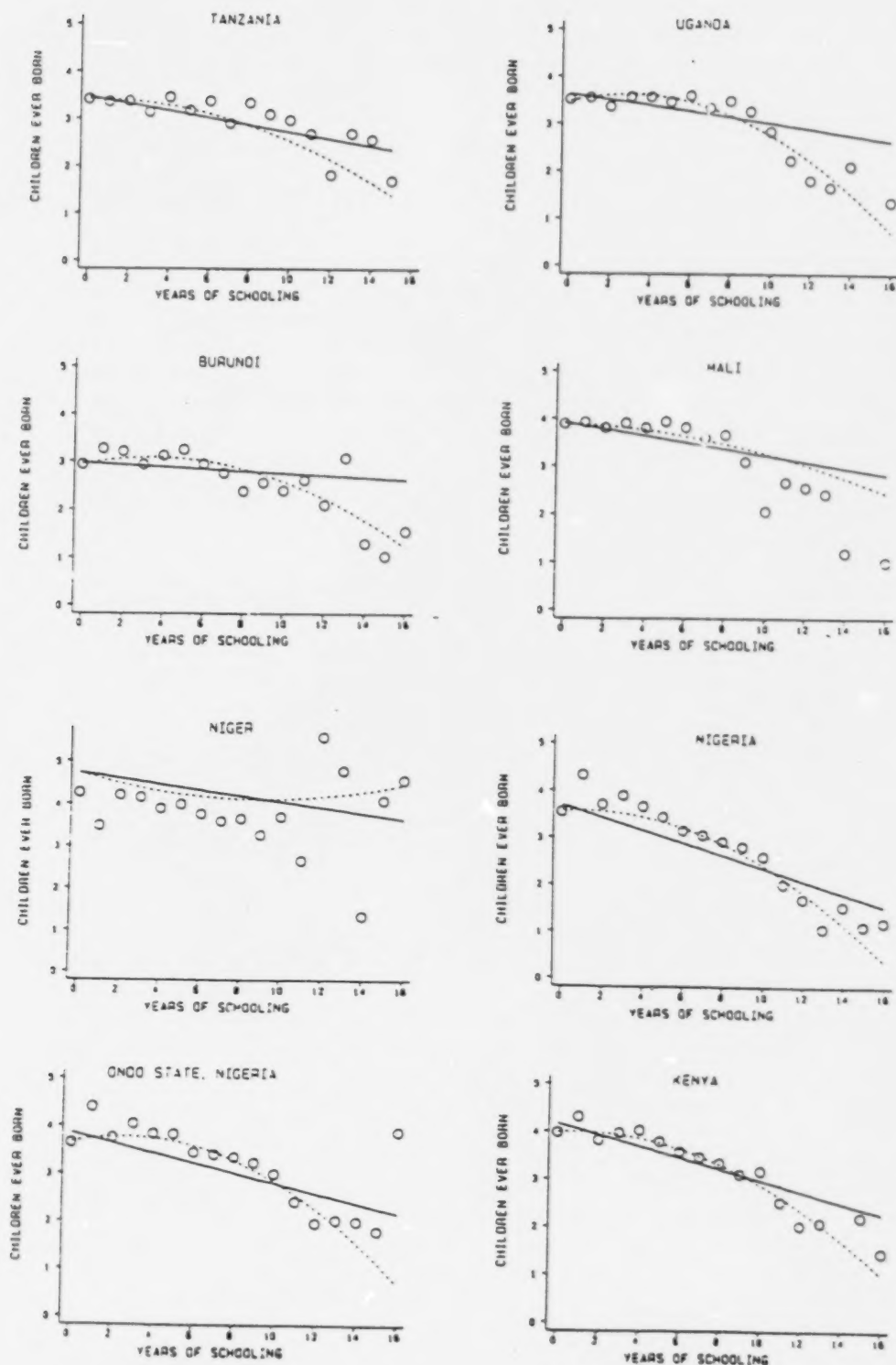
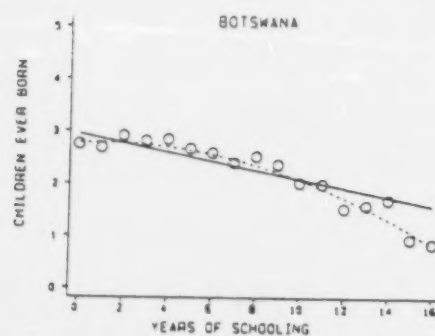
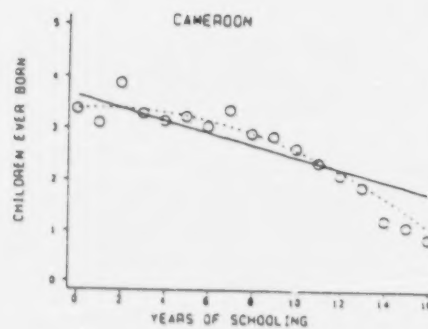
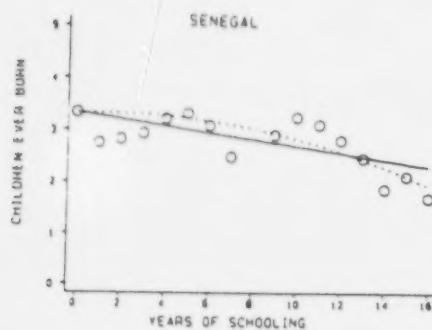
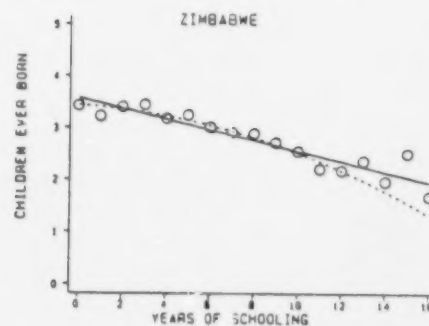
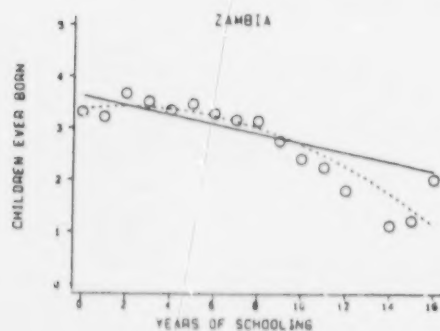
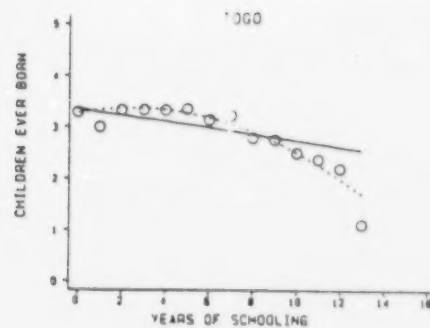
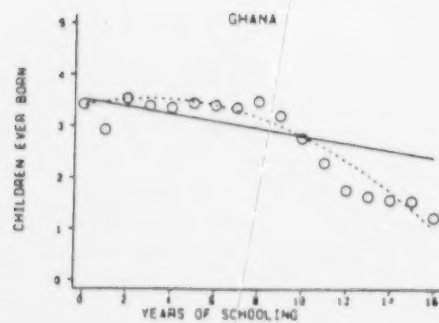


Figure 2 continued



specified, all reported coefficients are statistically significant at the .01 level or less. Coefficients that are not statistically significant at .05 or less are marked as "ns" (not significant). As in previous tables, the country results are presented in order of increasing 1991 GNP per capita.

The number of years of female schooling is negatively related to cumulative fertility in fourteen of the fifteen African data sets (see column 1, Table 5).<sup>18</sup> Despite the different and sometimes limited amounts of female schooling in these countries and different economic characteristics, the overall relation between female schooling and cumulative fertility is universally negative. The range in size of the regression coefficients across countries is quite wide, however, from -.06 in Uganda, Mali, Niger, Togo and Senegal to -.13 in Nigeria. With the exception of Nigeria, the countries with the largest schooling coefficients in absolute value — Kenya, Cameroon, Ondo State (Nigeria), Zimbabwe, Zambia and Botswana — have the highest mean years of female schooling in their samples (5 years or more). Botswana, Kenya, Zambia and Zimbabwe also have the highest proportion of women with any schooling (76 percent of more of women in the samples are schooled). Ondo State, Nigeria, has a proportion of schooled women (63 percent) similar to Uganda and Tanzania (65 percent) and Ghana (60 percent), but its schooling coefficient is basically twice the size of that of the other three countries. A much larger percentage of women in Ondo State have attended secondary school than in Uganda and Tanzania, however. In fact, all of the countries with high schooling coefficients have large shares of their sample with post-primary of schooling (39 percent of women in Ondo State, about 30 percent in Kenya, Zimbabwe, Cameroon and Botswana, 22 percent in Zambia). Three of the countries with the highest coefficients (Kenya, Zimbabwe and Botswana) also have very active family planning programs.<sup>19</sup> The fact that an equally strong or stronger effect of women's schooling on fertility is observed in Nigeria, Cameroon and Ondo State implies that female schooling can be associated with lower fertility, even in the absence of a vigorous family planning program, although at much greater cost to the small group of women who are educated. An interesting finding is that in countries such as Senegal, Togo, Mali, Niger and Uganda, the relation of women's schooling to cumulative fertility is not much different from that in Ghana, even though the share of women who are schooled in Ghana is higher and family planning services are far more developed. Indeed, considering that Ghana was one of the early leaders in family planning on the continent and has higher levels of schooling, one might have expected its relation between schooling and fertility to be closer to that of Kenya or Zimbabwe.

The magnitude of the linear schooling coefficients in column 1 does not seem to be related to GNP per capita. For example, Nigeria, with a per capita income of \$340 in 1991, has a schooling coefficient twice as large as that of Mali, Niger and Uganda, with similarly low incomes. Women's schooling has a stronger negative relation with fertility in Kenya, with per capita GNP of \$340, than it does in Botswana, with per capita income seven times larger (\$2530). Senegal and Zimbabwe had similar incomes in 1991, but the relationship between schooling and fertility in Senegal is only 60 percent as strong as it is in Zimbabwe. The lack of relationship is not surprising, since cumulative fertility is likely to reflect *past* levels of income and national averages hide differences in the distribution of income that may account for differential effects of schooling.

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18. The coefficient for Burundi was significant at .08.

19. The DHS surveys in Nigeria, Tanzania and Zimbabwe collected exogenous measures of the availability, price and quality of family planning with a separate survey of health and family planning facilities. The impact of service availability and quality of services on fertility and contraceptive use is being analyzed by Guilkey and Cochrane (Zimbabwe); Thomas and Maluccio (Zimbabwe); Feyisetan and Ainsworth (Nigeria) and Beegle (Tanzania).

**TABLE 5: The relationship between women's schooling and children ever born, Fourteen sub-Saharan countries**

| Ordinary least squares coefficients |                    |                   |                    |           |
|-------------------------------------|--------------------|-------------------|--------------------|-----------|
| COUNTRY                             | Years of schooling | 1-6 years         | 7-10 years         | 11+ years |
| Tanzania                            | -.0749             | -.295             | -.248              | -1.195    |
| Uganda                              | -.0603             | - ns              | -.276 <sup>a</sup> | -1.413    |
| Burundi                             | - ns               | .165 <sup>a</sup> | -.354 <sup>a</sup> | -.820     |
| Mali                                | -.0685             | - ns              | -.516              | -1.483    |
| Niger                               | -.0600             | -.300             | -.748              | ns        |
| Nigeria                             | -.134              | -.172             | -.684              | -1.600    |
| Ondo State, Nigeria                 | -.107              | + ns              | -.427              | -1.322    |
| Kenya                               | -.118              | -.249             | -.647              | -1.419    |
| Ghana                               | -.0710             | - ns              | -.403              | -1.498    |
| Togo                                | -.0614             | - ns              | -.479              | -1.204    |
| Zambia                              | -.0919             | + ns              | -.511              | -1.483    |
| Zimbabwe                            | -.102              | -.278             | -.598              | -1.133    |
| Senegal                             | -.0639             | -.269             | - ns               | -.873     |
| Cameroon                            | -.116              | - ns              | -.629              | -1.604    |
| Botswana                            | -.0855             | -.167             | -.497              | -1.227    |

a. Significant at .05.

Female primary schooling is associated with lower cumulative fertility in half of the fourteen countries (see column 2, Table 5). In these cases, women with some or complete primary schooling have .17 to .30 *fewer* children ever born than women with no schooling. Among these are Kenya, Zimbabwe and Botswana, with active family planning programs. The reasons why primary schooling has such a large negative relation with fertility in Senegal and Niger, where so few women are schooled, incomes are low and family planning is not widespread, should be explored. For example, Senegal had the second highest level of recurrent spending per primary student in 1980 (\$101) and of expenditure on primary teaching materials (\$3.10) of any of the fourteen countries, after Zimbabwe (Lockheed and Verspoor, 1991).

In six other Sub-Saharan countries, women with primary schooling do not have significantly different cumulative fertility than women with no schooling. This group of countries includes some with relatively high levels of female schooling (Cameroon, Zambia, Ghana, and Ondo State in Nigeria) as well as those with very low levels (Togo and Mali). In one country — Burundi — women with 1-6 years of schooling have significantly *higher* fertility than unschooled women. There are several plausible explanations for the results in these countries. First, female schooling may have no effect on fertility if the quality of instruction is so low that graduates never become literate, robbing them of a potentially marketable skill that would raise the value of their time and provide access to

new market opportunities. Second, dropout rates are often very high; adequate literacy and numeracy may require completion of the primary curriculum, which is attained by few in some countries. Third, a plausible explanation for the sometime non-relation between primary schooling and fertility or a positive relationship (as in Burundi) is the exclusion of variables like household income from the regressions. If children are "normal" goods (that is, as incomes rise parents want more of them, holding wages and other prices constant), then higher incomes should be associated with higher fertility. If there is a strong association of schooled women and higher incomes, and if income is not properly controlled for, then we might expect that the schooling coefficients are absorbing both the negative schooling and positive income effects, which cancel out. This would also imply that the linear coefficients in column 1 of Table 5 are underestimates of the negative relation between women's schooling and fertility.<sup>20</sup> Fortunately, we have been able to control for household assets — durable goods and quality of housing — which should minimize this problem if they are good proxies for income. Husband's education is also often used as a proxy for income. Results for these income and wealth proxies are reviewed below.

Women's secondary schooling is associated with lower fertility in all of the countries, has a greater negative effect than primary schooling, and the association is often 2-4 times stronger for higher secondary school (11 years and more) than for lower secondary (7-10 years) (columns 3 and 4, Table 5). The coefficients for 7-10 years are all negative and several times larger than the coefficients on the primary years. Seven to ten years of schooling is associated with a reduction in children ever born by .3 to .7 children, compared to women with no schooling. In Senegal, the lack of significance of 7-10 years of schooling is no doubt due to the small number of women in this category — 53 women, or only 1.2 percent of the sample. The coefficients on higher education (11 years and more) are far greater: in eleven of the fourteen countries, women with 11 or more years of schooling have had 1.2 to 1.6 fewer children than have women with no schooling. The very large negative association of women's higher secondary schooling and cumulative fertility persists across all of the countries in the sample, regardless of their level of development, distribution of schooling or intensity of family planning programs.<sup>21</sup> These results suggest that, with or without easy access to family planning, highly educated women *do* manage to lower their fertility; when supplies are scarce, highly educated women have the greatest access to contraceptive services by virtue of their education and probable income levels. However, in the three countries with more active family planning programs, even women with only primary instruction are able to lower their fertility.

#### Urban and rural samples

The percent of DHS respondents living in urban areas varies a great deal across the data sets. The most urbanized data sets are Botswana, Cameroon, Mali, Niger, Nigeria, Senegal, Ondo State (Nigeria), and Zambia with 40 percent or more of women living in urban areas. The least urbanized are Burundi, Tanzania and Uganda, with 20 percent or fewer women in urban areas. Table 6 presents the relation between female schooling and cumulative fertility for urban and rural women separately, based on specifications that used the years of schooling and levels of schooling variables. To help in interpreting the results, a fifth column has been added to show the percentage of women

20. This was found to be the case in Côte d'Ivoire, where omitting income from fertility regressions notably "weakened" the schooling coefficient in magnitude (Ainsworth, 1989). However, recent evidence from Ghana indicates that the opposing effects are not generalizable; identical specifications to the Côte d'Ivoire study found a negative relation between income and cumulative fertility in Ghana; omission of the income variable had no effect on the schooling coefficient (Oliver, forthcoming).

21. Niger is an exception; fewer than 0.1 percent of women had 11 or more years of schooling.

TABLE 6: Women's schooling and cumulative fertility in urban and rural areas  
Ordinary least squares coefficients

| COUNTRY             | Years of schooling | URBAN WOMEN |          |         | Pct w/no schooling |
|---------------------|--------------------|-------------|----------|---------|--------------------|
|                     |                    | 1-6 yrs     | 7-10 yrs | 11+ yrs |                    |
| Tanzania            | -.0908             | - na        | - na     | -1.151  | 18.3               |
| Uganda              | -.0834             | + .522*     | + na     | -.916   | 13.4               |
| Burundi             | -.0698             | + na        | - na     | -.817   | 30.5               |
| Mali                | -.0674             | + na        | -.511    | -1.363  | 63.8               |
| Niger               | -.054              | - na        | -.729    | - na    | 64.3               |
| Nigeria             | -.119              | + na        | -.412    | -1.259  | 29.4               |
| Ondo State, Nigeria | -.120              | - na        | -.453    | -1.381  | 29.0               |
| Kenya               | -.118              | -.499       | -.689    | -1.429  | 12.3               |
| Ghana               | -.0853             | + na        | -.482    | -1.393  | 26.8               |
| Togo                | -.0790             | - na        | -.473    | -1.326  | 37.6               |
| Zambia              | -.114              | + na        | -.306    | -1.269  | 7.4                |
| Zimbabwe            | -.128              | - na        | -.589    | -1.236  | 6.4                |
| Senegal             | -.0701             | -.300       | - na     | -.925   | 54.2               |
| Cameroon            | -.108              | + na        | - na     | -1.208  | 20.2               |
| Botswana            | -.0867             | -.263       | -.516    | -1.207  | 13.3               |

| COUNTRY             | Years of schooling | RURAL WOMEN |          |        | Pct w/no schooling |
|---------------------|--------------------|-------------|----------|--------|--------------------|
|                     |                    | 1-6 yrs     | 7-10 yrs | 11+ yr |                    |
| Tanzania            | -.0661             | -.271       | - na     | -1.164 | 39.4               |
| Uganda              | -.0444             | - na        | -.394*   | -1.349 | 39.9               |
| Burundi             | + na               | + na        | - na     | - na   | 82.4               |
| Mali                | - na               | + na        | + na     | n.a.   | 92.4               |
| Niger               | -.125              | -.524*      | -1.607   | -1.801 | 95.0               |
| Nigeria             | -.149              | -.286       | -.919    | -2.066 | 66.9               |
| Ondo State, Nigeria | -.0964             | + na        | -.416    | -1.319 | 42.2               |
| Kenya               | -.103              | - na        | -.538    | -1.379 | 28.2               |
| Ghana               | -.0586             | - na        | -.333    | -1.603 | 46.5               |
| Togo                | -.0488             | - na        | -.621    | - na   | 70.2               |
| Zambia              | -.0616             | - na        | -.660    | -1.476 | 28.3               |
| Zimbabwe            | -.088              | - na        | -.575    | -1.254 | 17.3               |
| Senegal             | - na               | - na        | + na     | - na   | 93.7               |
| Cameroon            | -.111              | - na        | -.853    | -1.659 | 49.1               |
| Botswana            | -.0801             | - na        | -.525    | -1.261 | 28.7               |

a. Significant at .05.

na. Not applicable; no women in this group.

with no schooling in each country and area of residence. While in urban areas in all countries substantial shares of women had some schooling, this is not the case in rural areas. In four countries, 80 percent or more of rural women had no schooling — Niger, Senegal, Mali and Burundi.

Except in three countries with small numbers of schooled women in rural areas, the overall negative relation between women's schooling and cumulative fertility holds in both urban and rural areas (column 1, Table 6). An extra year of female schooling is associated with .05 to .13 fewer children ever born in urban areas and .04 to .15 fewer children in rural areas, controlling for age and other exogenous regressors. In general, female schooling has a larger negative impact in urban areas. However, in Niger and Nigeria the negative effect of female schooling is stronger in rural than urban areas, and in Botswana and Cameroon the effects are the same. Relatively large negative schooling effects are found in rural areas of Nigeria (-.149), Niger (-.125), Cameroon (-.111), Kenya (-.103), Ondo State, Nigeria (-.0964) and Zimbabwe (-.0905). These results demonstrate that an urban environment is not necessary for women's schooling to have a depressing effect on fertility, and suggest that female schooling is a proxy for other characteristics beyond the opportunity cost of time.

The relation between the early years of schooling and cumulative fertility is weak in both urban and rural areas (column 2, Table 6). In half of the countries, partial or complete primary schooling has no effect on fertility in either urban or rural areas, when taken separately. In Uganda, Kenya, Senegal and Botswana, primary schooling suppresses fertility in urban areas by .3 to .5 children, compared to women with no schooling, but has no effect in rural areas. However, in three other countries (Tanzania, Nigeria, and Niger), primary schooling has a depressing effect on fertility in rural but not in urban areas, lowering it by .2 to .5 children compared to women with no schooling. Curiously, urban women with primary schooling in Uganda have half a child *more* than women with no schooling. The factors leading to negative primary schooling effects in some countries and not others, and particularly in rural areas are of great policy interest and warrant additional investigation.

The increasing effectiveness of schooling in lowering fertility as schooling rises is evident in both urban and rural areas (column 4, Table 6). The coefficients for 11 or more years of schooling are very large in both urban and rural areas, and the rural coefficients are on a par with or even larger than those for urban areas. Thus, with the exception of Burundi, Mali and Senegal, where no relationship exists between schooling and cumulative fertility in rural areas, in both urban and rural areas secondary schooling has an equally negative relation with fertility. In many of the countries, family planning services are not easily available in rural areas, yet very educated rural women (there are few of them) still find ways to lower their fertility proportionately with educated women in urban areas.

#### Age cohorts

There are many reasons why one might expect that the relation between women's schooling and fertility would change over time. First, as female enrollment rates rise, a greater percentage of each successive cohort has had schooling. Conceivably the level of schooling of the woman relative to the schooling of her cohort may alter the returns to schooling and thus the relation between schooling and fertility. Second, even were enrollment rates to remain constant, changes in the quality and content of schooling over time might result in changes in the "effectiveness" of women's schooling in altering fertility behavior. Third, over time other variables in the environment may also change, enhancing or detracting from the relationship. For example, one might expect that making family planning more available would alter schooling's effect on cumulative fertility by substituting for the schooling of poor women (lowering fertility even for women with no schooling) or by availing

more educated women of the means to keep their fertility low. Table 7 presents regression results for three cohorts of women — those 15-24, 25-34 and 35-49 — in each of the 15 DHS data sets. As was the case for rural women, for the two older cohorts (and especially those 35 and older) there are very few women with any schooling (see Annex 2). For the middle cohort, 86 percent of women in Niger, 78 percent in Mali and Senegal and 74 percent in Burundi had no schooling. For the oldest cohort, 94 percent of women in Mali and Niger, 91 percent in Senegal, 82 percent in Burundi, 81 percent in Togo, 74 percent in Nigeria and 69 percent in Ondo State, Nigeria, have had no schooling.<sup>22</sup> One should also keep in mind that the sample size for the cohorts is often one-third or less of the entire sample, and that the oldest cohort has the smallest sample size of the three. Given these qualifications, we do not expect to see strong results for the oldest cohort in most countries.

The overall relation between women's schooling and cumulative fertility is negative in the youngest and middle-aged cohorts in all of the DHS data sets (column 1 of Table 7). Even for the oldest cohort, half of the countries show relatively large negative coefficients. In only one country-cohort — women 35 and older in Burundi — is women's schooling *positively* correlated with cumulative fertility.

The negative relation between schooling and cumulative fertility is larger in the middle cohort than in the youngest cohort, except in Uganda, where the effect for women 25-34 is slightly smaller than for women 15-24. For the other countries, the coefficients for the middle group are sometimes 2-4 times larger than among younger women. If we assume that the quality of schooling has remained roughly constant over time and that economic factors have not changed, the results would suggest that the effect of women's schooling on fertility increases with the woman's age, implying that middle-aged educated women are not "catching up" with the fertility of others in their cohort to compensate for lower fertility while in the younger cohort.

The association of primary schooling with lower cumulative fertility is observed to a greater extent among the youngest cohort, although not universally (column 2, Table 7). Interestingly, Botswana, Ghana and Zambia, which have relatively high levels of schooling, show no significant effect of primary schooling in any of the cohorts. As one scans the results across cohorts and the different levels of schooling, the only coefficients that remain large and significant in the older cohort are generally those for 11 or more years of schooling. In Ghana, Tanzania and Cameroon, women 35 and older with more than 10 years of schooling have given birth to 2-2.5 fewer children than women of the same age with no schooling. The higher levels of schooling have large negative effects across all cohorts, and even in some countries with low levels of schooling in the older cohort.

#### Women's vs. men's schooling

Up to this point, the results have been based on the entire sample of women in each country, regardless of each woman's marital status. However, one issue of policy interest is the relative impact of men's and women's schooling on cumulative fertility. Controlling for husband's education is also of interest, since it is often used as proxy for household income and there is no income variable in the DHS data sets. It may be a better proxy for income than the ownership of durable goods, which is already being controlled for. As was suggested earlier, inclusion of an income proxy may alter the size of the women's schooling coefficients to the extent that they are correlated with income or husband's education. However, to examine these issues we must restrict ourselves to the sample of ever-married women in each data set. Depending on the country, the sample of ever-

22. Indeed, in countries and cohorts with so few schooled women, one has to wonder what selection process resulted in these particular women receiving schooling, and how this might bias the results.

TABLE 7: Women's schooling and cumulative fertility, by cohort  
Ordinary least squares regression coefficients

A. Women 15-24

| COUNTRY             | Years of schooling | 1-6 years | 7-10 years | 11+ years | Pct w/no schooling |
|---------------------|--------------------|-----------|------------|-----------|--------------------|
| Tanzania            | -.0360             | -.121     | -.257      | -.741     | 16.8               |
| Uganda              | -.0682             | -.180     | -.449      | -1.123    | 22.3               |
| Burundi             | - ns               | + ns      | - ns       | -.657     | 68.7               |
| Mali                | -.0393             | - ns      | -.350      | -1.260    | 71.4               |
| Niger               | -.074              | - ns      | -.771      | -1.172    | 73.2               |
| Nigeria             | -.0779             | -.191     | -.362      | -.919     | 32.2               |
| Ondo State, Nigeria | -.0794             | -.317     | -.581      | -.904     | 7.3                |
| Kenya               | -.104              | -.355     | -.589      | -1.197    | 6.3                |
| Ghana               | -.0381             | + ns      | -.200      | -.746     | 25.1               |
| Togo                | -.0404             | - ns      | -.357      | -.548     | 41.6               |
| Zambia              | -.0605             | - ns      | -.353      | -.971     | 12.5               |
| Zimbabwe            | -.109              | -.331     | -.606      | -1.049    | 4.8                |
| Senegal             | -.0314             | -.152*    | - ns       | -.411     | 70.1               |
| Cameroon            | -.0822             | -.209     | -.538      | -1.100    | 22.7               |
| Botswana            | -.0413             | - ns      | -.202      | -.572     | 9.0                |

B. Women 25-34

| COUNTRY             | Years of schooling | 1-6 years | 7-10 years | 11+ years | Pct w/no schooling |
|---------------------|--------------------|-----------|------------|-----------|--------------------|
| Tanzania            | -.0945             | -.426     | - ns       | -1.404    | 36.6               |
| Uganda              | -.0594             | + ns      | - ns       | -1.598    | 37.2               |
| Burundi             | -.0840             | - ns      | -1.012     | -1.293    | 74.5               |
| Mali                | -.0782             | + ns      | - ns       | -1.725    | 78.2               |
| Niger               | - ns               | - ns      | -.654*     | + ns      | 85.8               |
| Nigeria             | -.167              | -.219*    | -.943      | -2.052    | 56.5               |
| Ondo State, Nigeria | -.125              | + ns      | -.627      | -1.731    | 40.1               |
| Kenya               | -.107              | -.293     | -.740      | -1.389    | 25.1               |
| Ghana               | -.0736             | - ns      | -.399      | -1.514    | 37.9               |
| Togo                | -.104              | - ns      | -.881      | -1.907    | 62.7               |
| Zambia              | -.115              | + ns      | -.651      | -1.700    | 15.7               |
| Zimbabwe            | -.107              | -.490     | -.743      | -1.457    | 17.9               |
| Senegal             | -.106              | -.401     | - ns       | -1.417    | 77.6               |
| Cameroon            | -1.414             | + ns      | -.575*     | -1.595    | 31.1               |
| Botswana            | -.0792             | - ns      | -.594      | -1.106    | 27.4               |

## C. Women 35 and older

| COUNTRY             | Years of schooling  | 1-6 years          | 7-10 years         | 11+ years           | Pct w/no schooling |
|---------------------|---------------------|--------------------|--------------------|---------------------|--------------------|
| Tanzania            | -.0641              | - na               | - na               | -2.173              | 64.1               |
| Uganda              | - na                | + na               | + na               | -1.541 <sup>a</sup> | 55.6               |
| Burundi             | + na                | .551 <sup>a</sup>  | - na               | + na                | 81.9               |
| Mali                | - na                | + na               | - na               | - na                | 93.5               |
| Niger               | - na                | -.897 <sup>a</sup> | - na               | + na                | 94.4               |
| Nigeria             | -.0586              | + na               | - na               | -1.026              | 73.8               |
| Ondo State, Nigeria | - na                | + na               | + na               | -.961               | 69.0               |
| Kenya               | -.0716              | + na               | -.543 <sup>a</sup> | -1.556              | 49.2               |
| Ghana               | -.101               | - na               | -.624              | -2.519              | 62.1               |
| Togo                | - na                | + na               | - na               | - na                | 80.8               |
| Zambia              | -.0788              | + na               | - na               | -1.795              | 34.6               |
| Zimbabwe            | - na                | + na               | - na               | - na                | 24.1               |
| Senegal             | -.0764 <sup>a</sup> | - na               | + na               | -1.381              | 90.6               |
| Cameroon            | -.0800 <sup>a</sup> | - na               | - na               | -2.204              | 55.3               |
| Botswana            | -.113               | - na               | -.753              | -1.891              | 33.7               |

a. Significant at .05.

-married women may be as small as 45 percent of the total sample (Botswana) or as large as 86 percent of the sample (Mali). The restricted sample, conditioned on marital status, can be expected to show a smaller schooling effect for ever-married women than for all women, since the influence of schooling on delayed age at first birth of the unmarried women in the sample will not be included. Table 8 presents the ordinary least squares regression results for the linear specification of schooling, with and without the husband's schooling.

First, we compare the results for ever-married women in column 1 with the results for all women reported earlier in Table 5. In half of the countries the women's schooling coefficients on the sample of ever-married women are smaller than for the sample of all women, and in half they are roughly the same. In Uganda, the women's schooling coefficient for ever-married women is half of that for all women (refer back to Table 5). Ondo State, Kenya and Zimbabwe also show relatively large drops. In Niger, female schooling has no relation with cumulative fertility among ever-married women, although it is associated with lower fertility in the sample of all women; one fifth of the total sample is never-married. This result confirms the point made earlier that studies restricted to samples of ever-married women are understating the effect of female schooling on fertility.

Comparing the results in the two regressions without and with husband's schooling in Table 8, we see that husband's education is negatively correlated with fertility, when it is significant (col 3), and controlling for husband's education acts to *reduce* slightly the women's education coefficient (col 1 vs col 2). In Nigeria and Senegal, the relation between husband's schooling and cumulative fertility of his partner was positive but insignificant. Including the husband's schooling in the regression raises ever so slightly the results for women's schooling in these countries.

**TABLE 8: The schooling of ever-married women and their husbands and cumulative fertility**

| Country             | Sample size | Regression without husband's education:       | Regression with husband's education           |                                                 | Percent with no schooling |          |
|---------------------|-------------|-----------------------------------------------|-----------------------------------------------|-------------------------------------------------|---------------------------|----------|
|                     |             | Coefficient on woman's years of schooling (1) | Coefficient on woman's years of schooling (2) | Coefficient on husband's years of schooling (3) | Ever married women        | Husbands |
| Tanzania            | 6593        | -.0676                                        | -.0611                                        | -.0190*                                         | 42.5                      | 27.7     |
| Uganda              | 3657        | -.0337                                        | -.0309*                                       | - na                                            | 40.1                      | 18.0     |
| Burundi             | 2541        | - na                                          | - na                                          | + na                                            | 77.3                      | 57.7     |
| Mali                | 2750        | -.0618                                        | -.0453                                        | -.0256*                                         | 83.0                      | 84.3     |
| Niger               | 4982        | - na                                          | + na                                          | -.0588                                          | 87.6                      | 89.2     |
| Nigeria             | 6907        | -.112                                         | -.113                                         | + na                                            | 62.7                      | 53.5     |
| Ondo State, Nigeria | 2891        | -.0799                                        | -.0717                                        | - na                                            | 51.9                      | 40.8     |
| Kenya               | 4962        | -.0926                                        | -.0830                                        | -.0207*                                         | 30.0                      | 15.8     |
| Ghana               | 3296        | -.0698                                        | -.0569                                        | -.0414                                          | 46.0                      | 33.0     |
| Togo                | 2318        | -.0540                                        | -.0424                                        | -.0218*                                         | 68.0                      | 49.7     |
| Zambia              | 5115        | -.0877                                        | -.0763                                        | -.0223                                          | 21.2                      | 11.1     |
| Zimbabwe            | 2755        | -.0794                                        | -.0617                                        | -.0384                                          | 16.3                      | 12.4     |
| Senegal             | 3001        | -.0567                                        | -.0597                                        | + na                                            | 88.6                      | 90.2     |
| Cameroon            | 2878        | -.111                                         | -.1000                                        | - na                                            | 41.35                     | 36.31    |
| Botswana            | 1954        | -.0940                                        | -.0703                                        | -.0434                                          | 27.9                      | 35.4     |

Finally, the negative association of women's schooling on fertility is stronger than that of men's schooling. In 13 of the 15 data sets women's schooling has a significant negative association with fertility, while this is true of husband's education in only 8 countries. Only in Niger is the husband's education associated with a greater negative effect on fertility than the wife's education (which is insignificant). The effect of husband's schooling is between one quarter and two-thirds of the size of the women's schooling coefficients. In Kenya, for example, an additional year of women's schooling is associated with .09 fewer children, while an additional year for men is associated with a reduction in only .02 children. Investments in women's schooling, therefore, are likely to have a greater impact on fertility than investments in male schooling — and the effects of women's schooling are even greater in the sample of all women.

#### Wealth effects

In the results presented so far, we have been controlling for several variables thought to be good proxies for the income of the women's households: whether the household owns a radio, a television or a bicycle, and the nature of the flooring material in the dwelling. And in Table 8, husband's education was entered as a proxy for income in the sample for ever-married women. Economic theory provides no particular predictions concerning the effect that these measures of

income or wealth should have on fertility. Economists call a good a "normal" good if an increase in income is associated with increased consumption of it, holding constant the quality. This may be true for children. However, historically we have often seen higher income associated with lower fertility. When parents reach a certain income level, they often choose to invest more in each child (child "quality") and to have fewer children. Thus, while the objective of this paper is to examine the relation between women's schooling and fertility, it is also of interest to understand the likely effect of raising incomes on fertility, holding constant women's schooling.

Table 9 shows the percent of women whose households owned the three assets, and whose dwellings had cement, tile, polished wood or parquet flooring. The countries are listed in order of increasing GNP per capita, but this does not seem to have a strong relation to the ownership of durable goods in the individual data sets. Roughly 40-70 percent of women's households had radios, 1-29 percent had television sets, 10-39 percent had bicycles and 12-79 percent had houses with better flooring. Table 10 shows the relationship between each of these variables and fertility, taken from the same regressions as column 1 of Table 5. The sign of the effect is reported in each cell and was individually statistically significant at .05, unless noted with "ns". For example, a "plus" sign in the cell for bicycle in Tanzania means that cumulative fertility was higher in Tanzania for women in households with a bicycle, when controlling for all of the other variables (age, education, urban residence<sup>23</sup>, region, ethnic group, religion, other assets). The asset variables were jointly statistically significant in all countries except Cameroon and Niger.

The relationship between bicycle ownership and cumulative fertility is positive in 12 of the 15 data sets, and this is often at variance with the results for the other assets and durable goods. This suggests that the possession of a bicycle may be proxying for something other than income. This may also reflect that those who own bicycles are those who live far away from major centers. What about the patterns for the other assets? Ignoring for a minute the coefficient on bicycles, there are four countries for which the income proxies seem to be associated with *lower* fertility — Tanzania, Ghana, Togo and Botswana. In all four of these cases, the relation between husband's schooling and fertility was also negative. The results for Ghana are also consistent with other studies that have found a negative relationship between household consumption (a proxy for income) and cumulative fertility.<sup>24</sup> The results for Nigeria, on the other hand, suggest that children are normal goods. Each of the assets is associated with *higher* cumulative fertility and the effect of husband's schooling, while insignificant, had a positive sign in Table 8. The other assets in the Ondo State, Nigeria, data set are also positive but insignificant. Thus, in Nigeria we can expect increases in income to *raise* cumulative fertility, while increases in female schooling will act in the opposite direction to lower it. A similar positive relationship between household consumption and fertility has been found in Côte d'Ivoire (Ainsworth, 1990; Benefo and Schultz 1994; Montgomery and Kouamé 1993). Results for the other countries are inconclusive. In Zimbabwe, the signs on all assets except bicycle are negative but not all significant, while husband's schooling also showed a negative relation with fertility. Kenya shows a similar pattern, although the sign on radio is positive, and Senegal shows the same pattern, except the sign on husband's schooling was positive and insignificant in Table 8.

23. In all data sets except Burundi, Mali and Zambia, urban residence was associated with *lower* cumulative fertility, controlling for all other variables. In these three cases, there was no significant effect of urban residence on fertility.

24. See Benefo and Schultz (1994) and Oliver (1994b).

TABLE 9: Percent of women living in households with different indicators of income

| Country             | Radio | Television | Bicycle | Good flooring |
|---------------------|-------|------------|---------|---------------|
| Tanzania            | 36.7  | 1.1        | 28.1    | 19.2          |
| Uganda              | 32.7  | 3.2        | 33.2    | 21.6          |
| Burundi             | 25.1  | 2.6        | 10.4    | 12.0          |
| Mali                | 59.1  | 5.7        | 38.6    | 32.2          |
| Niger               | 47.6  | 11.7       | 8.0     | 28.8          |
| Nigeria             | 61.9  | 28.5       | 29.4    | 58.2          |
| Ondo State, Nigeria | 61.7  | 21.3       | 14.5    | 78.9          |
| Kenya               | 62.3  | 7.1        | 28.0    | 34.8          |
| Ghana               | 41.3  | 9.4        | 11.4    | 70.5          |
| Togo                | 52.6  | 13.0       | 37.4    | 74.5          |
| Zambia              | 44.8  | 10.7       | 21.5    | 51.1          |
| Zimbabwe            | 45.8  | 14.6       | 25.8    | 64.5          |
| Senegal             | 79.7  | 17.5       | 11.0    | 56.9          |
| Cameroon            | 61.8  | 23.7       | 14.1    | 53.7          |
| Botswana            | 70.2  | 9.3        | 27.6    | 68.5          |

TABLE 10: Relation between ownership of assets (income proxies) and cumulative fertility

| Country             | Radio | Television | Bicycle | Good flooring |
|---------------------|-------|------------|---------|---------------|
| Tanzania            | -     | -          | +       | -             |
| Uganda              | + ns  | - ns       | +       | + ns          |
| Burundi             | - ns  | -          | +       | + ns          |
| Mali                | + ns  | - ns       | +       | + ns          |
| Niger               | - ns  | - ns       | +       | - ns          |
| Nigeria             | +     | +          | +       | +             |
| Ondo State, Nigeria | + ns  | + ns       | +       | + ns          |
| Kenya               | + ns  | -          | +       | - ns          |
| Ghana               | -     | -          | + ns    | -             |
| Togo                | + ns  | -          | +       | -             |
| Zambia              | + ns  | -          | +       | + ns          |
| Zimbabwe            | - ns  | - ns       | +       | -             |
| Senegal             | -     | - ns       | + ns    | - ns          |
| Cameroon            | + ns  | + ns       | - ns    | - ns          |
| Botswana            | + ns  | -          | +       | -             |

## VI. Women's schooling and contraceptive use

### National samples

Contraceptive use is related directly to a woman's demand for children. Therefore, all of the factors leading more educated women to have fewer children should result in a positive relation between education and contraceptive use. In addition, educated women may be more likely to use contraception because information about the availability, correct use, side effects, costs, and so forth, may be less difficult and costly for educated women to assimilate, and may make them more effective and satisfied users. Levels of current use of modern contraception in the DHS samples of all women used in the regressions are presented in Table 11, for urban and rural women and for different levels of schooling. Both in our data and in virtually all tabulated results to date, urban women and women with more schooling (even those with primary schooling) have higher rates of contraceptive use than rural and less educated women (Jejeeboy 1992; NRC 1993).

Figure 3 shows graphically the predicted relation between years of women's schooling and contraceptive use among the sample of all women for the fifteen data sets, holding the value of all

**TABLE 11: Percent of women currently using a modern method of contraception, by residence and women's education**

| Country               | Year    | Residence |       |       | Women's Education |      |      |      |
|-----------------------|---------|-----------|-------|-------|-------------------|------|------|------|
|                       |         | All       | Urban | Rural | 0                 | 1-6  | 7-10 | 11+  |
| Botswana <sup>a</sup> | 1988    | 31.8      | 38.1  | 25.0  | 18.7              | 30.4 | 39.9 | 54.4 |
| Burundi               | 1987    | 2.3       | 11.5  | 0.5   | 0.8               | 5.0  | 9.74 | 19.4 |
| Cameroon              | 1991    | 5.4       | 7.8   | 2.2   | 1.7               | 4.6  | 7.3  | 13.0 |
| Ghana                 | 1988    | 4.7       | 6.4   | 3.8   | 3.0               | 5.2  | 5.5  | 9.8  |
| Kenya <sup>a</sup>    | 1989    | 15.4      | 21.3  | 13.2  | 9.9               | 15.7 | 13.9 | 27.2 |
| Mali                  | 1987    | 2.0       | 4.8   | .05   | 0.7               | 3.9  | 12.1 | 16.7 |
| Niger                 | 1992    | 5.0       | 11.6  | 0.7   | 3.6               | 9.8  | 12.7 | 15.6 |
| Nigeria               | 1990    | 9.4       | 16.3  | 4.0   | 2.8               | 10.7 | 14.6 | 21.2 |
| Ondo State, Nigeria   | 1986/87 | 5.8       | 7.5   | 4.6   | 1.9               | 3.3  | 7.9  | 14.8 |
| Senegal               | 1986    | 2.7       | 5.9   | 0.4   | 0.9               | 5.6  | 9.4  | 13.4 |
| Tanzania <sup>a</sup> | 1991/92 | 5.2       | 10.9  | 3.8   | 2.2               | 6.1  | 10.7 | 16.8 |
| Togo                  | 1988    | 3.4       | 6.2   | 1.9   | 1.8               | 4.4  | 8.3  | 14.8 |
| Uganda <sup>a</sup>   | 1988/89 | 3.4       | 10.7  | 1.5   | 1.0               | 2.8  | 9.6  | 15.6 |
| Zambia <sup>a</sup>   | 1992    | 6.7       | 10.8  | 3.0   | 2.7               | 4.7  | 11.3 | 27.9 |
| Zimbabwe <sup>a</sup> | 1988    | 27.2      | 33.7  | 24.0  | 23.5              | 27.8 | 23.2 | 33.8 |

a. Primary schooling 1 to 7 years, and the next highest level is 8 to 10 years for these countries.

Note: Unfortunately, these differentials are not produced in the DHS country reports for all women (only for ever-married women). Thus, these differentials in contraceptive prevalence rates have been computed from the data used for analysis and are not weighted to compensate for over-sampling.

Source: DHS data sets.

Figure 3. Predicted current and ever use of modern contraception and female schooling

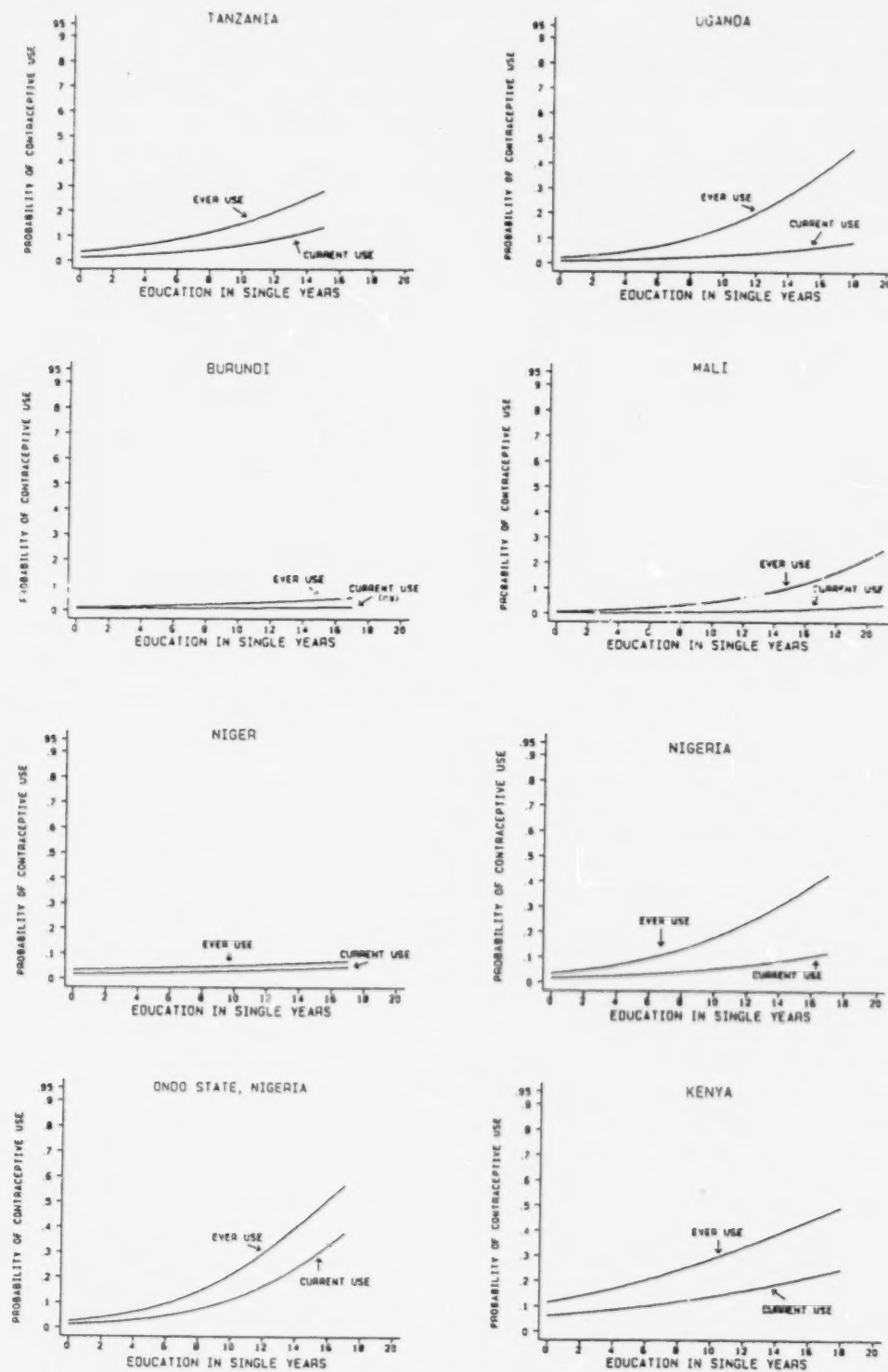
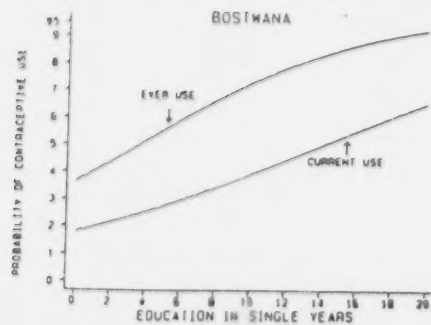
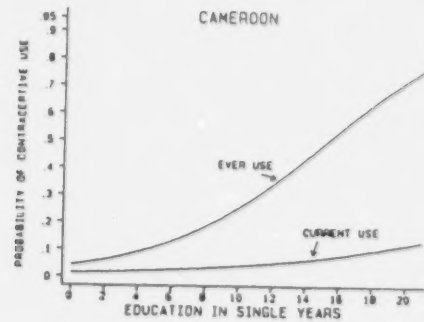
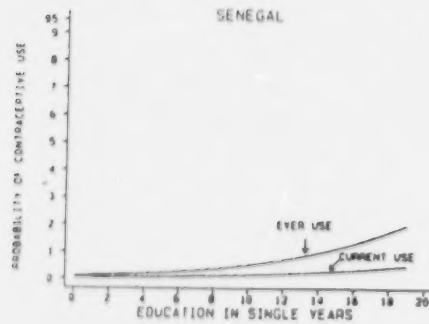
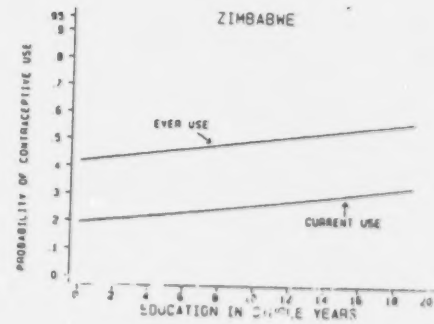
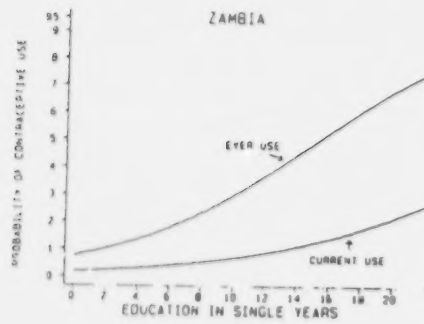
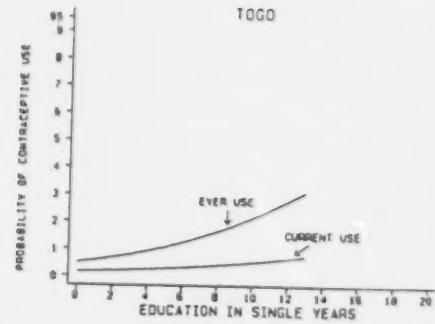
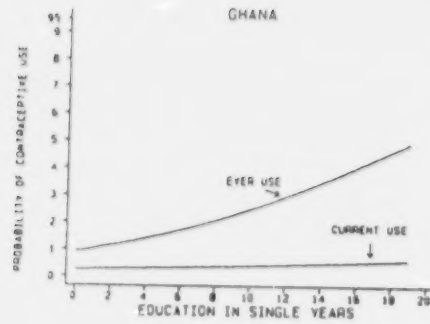


Figure 3 continued



other variables in the regressions at their means.<sup>25</sup> These predictions are based on the results of logit regressions of current or ever use of contraception on the same set of independent regressors in the fertility work: age, age squared, urban residence, dummy variables for ownership of bicycles, radios and televisions, dummy variable for the quality of flooring, religion, region and ethnic group.<sup>26</sup> In all cases, an increase in female education is associated with increases in contraceptive use, and female schooling has an even stronger relationship with ever use, as expected. The figures across countries differ in two respects: (1) the level of contraceptive use that is the starting point, for women with zero years of schooling (the y-axis intercept); and (2) the slope and curvature of the relationship. For example, Burundi's curves begin at a very low level of contraceptive use and are, for all intents and purposes, flat. In Zimbabwe, the starting level is higher, the curve has a more positive slope but the slope is still fairly unchanging. In Kenya, the starting level is higher and the slope increases at higher levels of schooling.

Moving along each curve, the slope at any given point is the rate of increase in contraceptive use associated with a marginal increase in education. The marginal change in current contraceptive use associated with a one-year change in women's schooling, evaluated at the mean of the sample and at 3, 6 and 10 years of schooling is shown in Table 12 for the national samples. As the amount of female schooling increases, the slopes of the curves are increasing, which implies that the marginal impact of women's schooling on predicted contraceptive use is increasing with the amount of schooling. Among women with three years of schooling, an additional year of schooling will raise current contraceptive use by half a percentage point or more in Nigeria, Kenya, Zimbabwe and Botswana. At 6 years of schooling, an additional year is associated with a half-percentage point increase in current use in Tanzania and Zambia, a one-percentage point increase in Nigeria and Kenya and a two-percentage point increase in Botswana. At 10 years of female schooling, an additional year of schooling is associated with a one-percent or greater increase in current use in Tanzania, Nigeria, Kenya and Botswana. By comparison, the gains from additional female schooling to current use are lowest in Burundi, Mali, Niger, Ghana and Senegal. Marginal effects for ever use are shown in Annex 3. Additional schooling is associated with much higher ever use of contraception, as is implied in Figure 3.

In interpreting these results, it is important to note that moving along the curves in Figure 3 does not simulate well the effect of making a large change in the average levels of schooling of women, which would shift the curves upward. For example, the effect of raising the mean levels of education in Mali from 1 year to 6 years cannot be gleaned from comparing contraceptive use at one and six years of schooling along the curve. In fact, in general, the countries with the highest mean levels of schooling — Zimbabwe, Botswana, Kenya, Cameroon, Zambia and Ondo State (Nigeria), also have the highest curves. The intercepts absorb the effects of other factors that could not be controlled for, such as, but not limited to, the availability of contraception, quality of schooling, returns to women's schooling, etc. Thus, the countries with the most vigorous family planning programs are among those with higher intercepts. The relationship between female schooling and contraceptive use does not seem to have any relation to the level of income per capita. For example,

25. In instances where a coefficient was not statistically significant, the curve is labelled (ns).

26. Unfortunately, a key variable of policy interest — the availability of family planning services — was available for only three of the data sets (Tanzania, Nigeria, Zimbabwe). In order to maintain cross-country comparability, controls for the availability of family planning are not included here. However, this has been analyzed by Beegle (1994) for Tanzania, Feyisetan and Ainsworth (1995) for Nigeria and Thomas and Maluccio (1995) for Zimbabwe.

**TABLE 12: Marginal effect of raising female schooling by one year on current use of contraception (percentage points)**

| <i>COUNTRY</i>      | <i>At the mean level of female schooling</i> | <i>At 3 years of female schooling</i> | <i>At 6 years of female schooling</i> | <i>At 10 years of female schooling</i> |
|---------------------|----------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|
| Tanzania            | .40                                          | .33                                   | .53                                   | .94                                    |
| Uganda              | .18                                          | .16                                   | .24                                   | .40                                    |
| Burundi             | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Mali                | .03                                          | .04                                   | .06                                   | .12                                    |
| Niger               | .11                                          | .13                                   | .15                                   | .19                                    |
| Nigeria             | .31                                          | .28                                   | .40                                   | .63                                    |
| Ondo State, Nigeria | .87                                          | .56                                   | 1.04                                  | 2.23                                   |
| Kenya               | .79                                          | .66                                   | .82                                   | 1.08                                   |
| Ghana               | .15                                          | .14                                   | .16                                   | .19                                    |
| Togo                | .25                                          | .27                                   | .39                                   | .62                                    |
| Zambia              | .48                                          | .36                                   | .52                                   | .83                                    |
| Zimbabwe            | .67                                          | .63                                   | .67                                   | .72                                    |
| Senegal             | .07                                          | .08                                   | .12                                   | .20                                    |
| Cameroon            | .29                                          | .23                                   | .32                                   | .50                                    |
| Botswana            | 2.22                                         | 1.92                                  | 2.24                                  | 2.56                                   |

Senegal and Zimbabwe have the same GNP per capita but the relationship is quite different in the two countries.

These results represent the relationship between female schooling and contraceptive use at the time of the DHS surveys, holding all other factors constant. However, they do not represent an immutable relationship or "law" unique and unchanging for every country. The patterns are subject to change. For example, for Burundi, Mali and Niger, contraceptive use is low, women's schooling is low, child mortality is high and the curve is fairly flat. This does not mean that increases in female schooling will not bring about increases in contraceptive use. Rather, as the mean level and quality of female schooling and the returns to education rise, these curves will very likely shift upward and steepen in slope. Likewise, the steepness of the relationship should also be related to the availability of contraception.<sup>27</sup> In Zimbabwe, for example, the slope of the curve is fairly flat. Thus, it may be the availability of contraception that makes differentials in education more muted in Zimbabwe than in countries like Cameroon, which shows sharp curvature upward. One of the objectives of population policy is to shift these curves upward to achieve higher levels of contraceptive use and lower fertility for a given level of schooling. One can well imagine that diagrams for Zimbabwe and Botswana 30 years ago would have looked quite different than they do now, following major investments in female schooling and better contraceptive services.

27. Unfortunately, the exogenous availability of contraception was not measured in most of these data sets, so we cannot explore the substitutability of female schooling and contraceptive services.

### Urban and rural samples

Table 13 shows the marginal change in current contraceptive use associated with a one-year change in women's schooling for urban and rural women. **The effect of schooling on contraceptive use is generally greater in urban than in rural areas.** At the mean level of female schooling in the samples, an additional year of schooling is associated with .4 to 2.6 percentage points increase in current contraceptive use in urban areas and .1 to 1.8 percentage points increase in rural areas. Ghana stands out as an exception, however. The marginal effect of female schooling is very low in urban areas and rural areas and, unlike the other countries, schooling has a larger effect on current use in rural than in urban areas (.17 vs .06 percentage points, respectively). This is in contrast to results presented earlier that showed the effect of schooling on fertility to be greater in urban than in rural areas of Ghana.

### Age cohorts

The marginal effect of female education on current contraceptive use is higher among older women (see Table 14). It is highest in the oldest age group (35 and older) in six of the eleven countries for which regressions could be run: Tanzania, Kenya, Zambia, Zimbabwe, Cameroon and Botswana. In four countries the effect is higher among middle-aged women — Niger, Nigeria, Ghana and Senegal — while in Ondo State, Nigeria, the effect on the youngest and oldest women is similar.

### Women's vs. men's schooling

Figure 4 shows the relationship between education and current use of contraception for both women and their husbands in the restricted samples of ever-married women for 12 of the 14 countries.<sup>28</sup> The slopes of the curves at three common values of education are shown in Table 15. There are at least three patterns here. First, in seven of the thirteen data sets, husband's schooling has no significant effect on current contraceptive use: Uganda, Mali, Niger, Ondo State, Zimbabwe, Cameroon and Botswana. These countries have little in common in terms of mean levels of schooling, income or the strength of family planning activities. In five countries, the effect of women's schooling is generally higher than the effect of men's schooling at all levels of schooling: Tanzania, Nigeria, Kenya, Togo and Zambia. This is particularly noticeable for Tanzania and Kenya where, at higher levels of schooling, the marginal effect for women is roughly three times the marginal effect for men. Third, in Senegal the effect of male schooling on contraceptive use is somewhat greater than the effect of female schooling.

Figure 4 shows a curious "crossing" pattern in the relative importance of female vs. male schooling among ever married women: the husband's schooling has a more powerful effect at low levels of schooling, but the wife's schooling has a stronger effect at higher levels. In Kenya, this "crossing point" seems to be at about 3 years of schooling, while in Botswana and Zimbabwe it seems to be at about 5 years, although husband's schooling is not statistically significant in the latter two countries. At higher levels of female schooling in Zimbabwe and Botswana the slope of the relationship becomes quite steep for female schooling, but is flat for the husband. These are the three

28. In Burundi and Ghana, neither the wife's nor the husband's schooling was statistically significant determinant of contraceptive use in the sample of ever-married women. This may be due to multicollinearity. Recall also from the discussion of fertility that selection of ever married women resulted in dropping a large share of the samples in many countries and should produce a sample with a higher demand for children and lower contraceptive use.

TABLE 13: Marginal effect of raising female schooling by one year on current use of contraception (percentage points), urban and rural samples

| URBAN WOMEN         |                                       |                                |                                |                                 |
|---------------------|---------------------------------------|--------------------------------|--------------------------------|---------------------------------|
| COUNTRY             | At the mean level of female schooling | At 3 years of female schooling | At 6 years of female schooling | At 10 years of female schooling |
| Tanzania            | .79                                   | .57                            | .80                            | 1.24                            |
| Uganda              | .55                                   | .44                            | .53                            | .68                             |
| Mali                | .43                                   | .46                            | .67                            | 1.09                            |
| Niger               | .59                                   | .61                            | .72                            | .87                             |
| Nigeria             | .68                                   | .51                            | .67                            | .95                             |
| Ondo State, Nigeria | 1.09                                  | .64                            | 1.08                           | 2.02                            |
| Kenya               | 1.30                                  | .96                            | 1.20                           | 1.55                            |
| Ghana               | + ns                                  | + ns                           | + ns                           | + ns                            |
| Togo                | .77                                   | .67                            | 1.06                           | 1.87                            |
| Zambia              | .94                                   | .57                            | .83                            | 1.33                            |
| Zimbabwe            | .95                                   | .87                            | .92                            | .99                             |
| Senegal             | .40                                   | .35                            | .51                            | .83                             |
| Cameroon            | .43                                   | .32                            | .42                            | .56                             |
| Botswana            | 2.61                                  | 2.23                           | 2.54                           | 2.79                            |

| RURAL WOMEN         |                                       |                                |                                |                                 |
|---------------------|---------------------------------------|--------------------------------|--------------------------------|---------------------------------|
| COUNTRY             | At the mean level of female schooling | At 3 years of female schooling | At 6 years of female schooling | At 10 years of female schooling |
| Tanzania            | .32                                   | .28                            | .48                            | .93                             |
| Nigeria             | .08                                   | .10                            | .16                            | .31                             |
| Ondo State, Nigeria | .75                                   | .52                            | 1.08                           | 2.61                            |
| Kenya               | .61                                   | .53                            | .67                            | .88                             |
| Ghana               | .17                                   | .15                            | .19                            | .25                             |
| Zambia              | .21                                   | .19                            | .26                            | .40                             |
| Zimbabwe            | + ns                                  | + ns                           | + ns                           | + ns                            |
| Botswana            | 1.83                                  | 1.63                           | 1.94                           | 2.32                            |

**TABLE 14: Marginal effect of raising female schooling by one year on current use of contraception (percentage points), by cohort**

| <b>AGE 15-24</b>    |                                              |                                       |                                       |                                        |
|---------------------|----------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|
| <i>COUNTRY</i>      | <i>At the mean level of female schooling</i> | <i>At 3 years of female schooling</i> | <i>At 6 years of female schooling</i> | <i>At 10 years of female schooling</i> |
| Tanzania            | .02                                          | .01                                   | .02                                   | .03                                    |
| Ondo State, Nigeria | 1.72                                         | .29                                   | .80                                   | 2.86                                   |
| Kenya               | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Togo                | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Zambia              | .16                                          | .12                                   | .17                                   | .25                                    |
| Zimbabwe            | + ns                                         | + ns                                  | - ns                                  | - ns                                   |
| Cameroon            | .32                                          | .15                                   | .30                                   | .79                                    |
| Botswana            | 1.93                                         | 1.43                                  | .180                                  | 2.30                                   |

| <b>AGE 25-34</b> |                                              |                                       |                                       |                                        |
|------------------|----------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|
| <i>COUNTRY</i>   | <i>At the mean level of female schooling</i> | <i>At 3 years of female schooling</i> | <i>At 6 years of female schooling</i> | <i>At 10 years of female schooling</i> |
| Tanzania         | .07                                          | .06                                   | .09                                   | 1.48                                   |
| Niger            | .22                                          | .27                                   | .34                                   | .47                                    |
| Nigeria          | .26                                          | .25                                   | .33                                   | .49                                    |
| Kenya            | 1.19                                         | 1.04                                  | 1.23                                  | 1.51                                   |
| Ghana            | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Zambia           | .69                                          | .51                                   | .70                                   | 1.05                                   |
| Zimbabwe         | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Senegal          | .14                                          | .17                                   | .28                                   | .54                                    |
| Cameroon         | .37                                          | .30                                   | .40                                   | .56                                    |
| Botswana         | 2.31                                         | 2.17                                  | 2.33                                  | 2.41                                   |

| <b>AGE 35 AND OLDER</b> |                                              |                                       |                                       |                                        |
|-------------------------|----------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|
| <i>COUNTRY</i>          | <i>At the mean level of female schooling</i> | <i>At 3 years of female schooling</i> | <i>At 6 years of female schooling</i> | <i>At 10 years of female schooling</i> |
| Tanzania                | 1.00                                         | 1.27                                  | 2.19                                  | 3.92                                   |
| Niger                   | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Nigeria                 | .16                                          | .19                                   | .26                                   | .41                                    |
| Ondo State, Nigeria     | .55                                          | .69                                   | 1.17                                  | 2.19                                   |
| Kenya                   | 1.60                                         | 1.60                                  | 1.97                                  | 2.44                                   |
| Ghana                   | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Zambia                  | .77                                          | .70                                   | 1.01                                  | 1.59                                   |
| Zimbabwe                | 1.13                                         | 1.08                                  | 1.22                                  | 1.39                                   |
| Senegal                 | + ns                                         | + ns                                  | + ns                                  | + ns                                   |
| Cameroon                | .51                                          | .52                                   | .72                                   | 1.07                                   |
| Botswana                | 1.99                                         | 1.90                                  | 2.15                                  | 2.40                                   |

countries where fertility decline is underway. Graphs of ever use of contraception by husbands and wives show similar but more dramatic results, since baseline levels of ever use are much higher (see Annex 3). Niger and Senegal still have very flat, low curves for both wives and husbands, while the gaps between the effects of female and male schooling seem greater for most countries. Female schooling affects ever use among married women in all countries except Burundi, and male schooling in all countries except Zimbabwe. Zimbabwe and Botswana again show clear crossing patterns in the relative importance of male and female schooling, as for current use. However, Zambia and Kenya also show evidence of the "crossing" of effectiveness of female and male schooling at low levels of schooling.

#### Wealth effects

In the fertility analysis we found that income had a negative relation with fertility in most countries, particularly Tanzania and Ghana, and a positive effect in Nigeria. Since the demand for contraception is derived directly from the demand for children, we expect the effect of proxies for income or wealth to enter the regressions with a sign opposite to that in the fertility regressions. In Table 16, all of the assets that are statistically significant have a positive relation with contraceptive use. While bicycle ownership is positively related to fertility in all countries, it has no relation with contraceptive use in any. Further, none of the assets is related to contraceptive use in Burundi, Ondo State or Ghana. The strongest evidence for wealth effects on contraceptive use are found in Tanzania, Nigeria, Kenya, Zambia, and Zimbabwe, where two or more of the proxies are statistically significant.

**Figure 4. Predicted current use of contraception according to female and male schooling, sample of ever-married women**

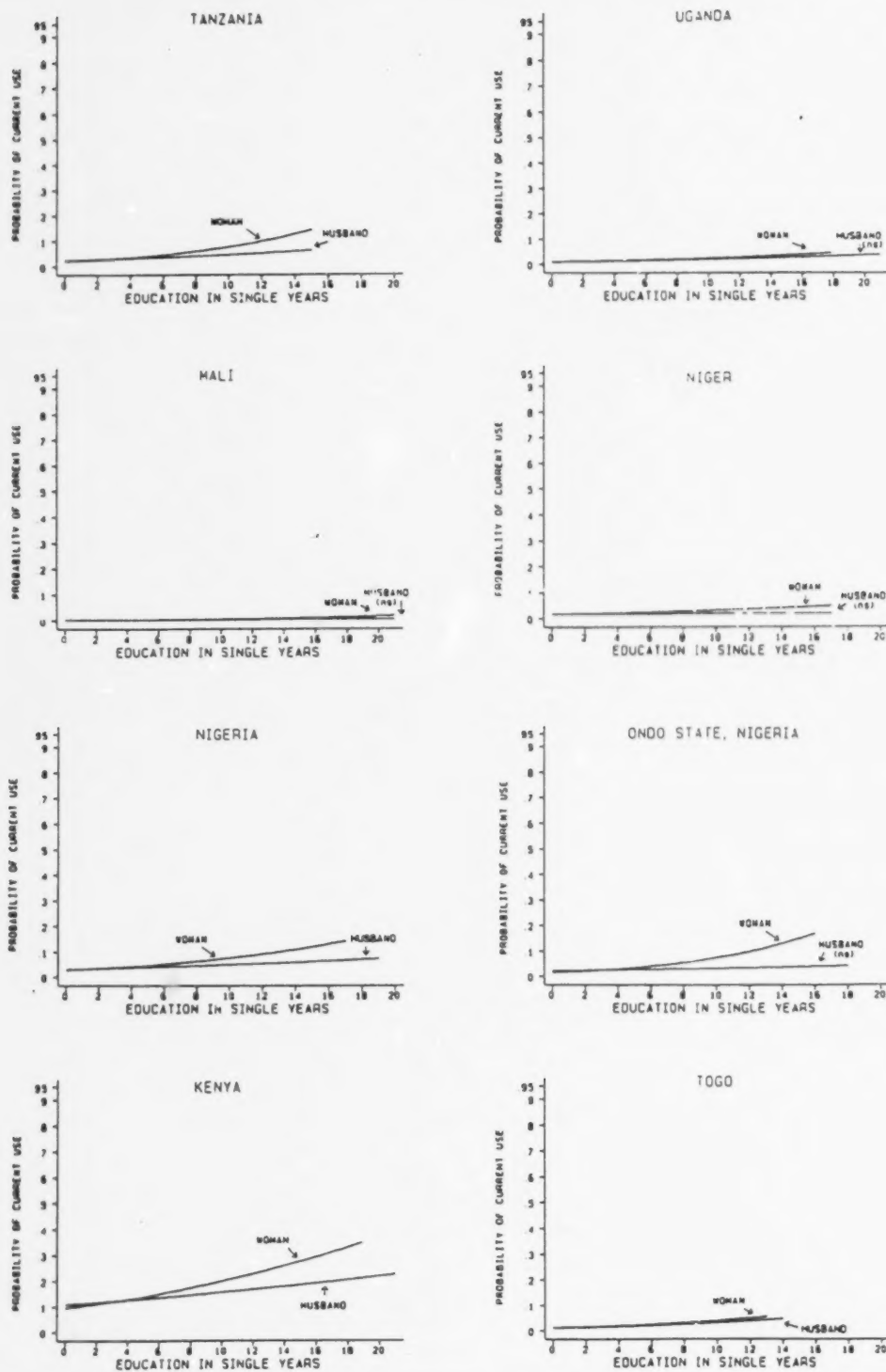


Figure 4 continued

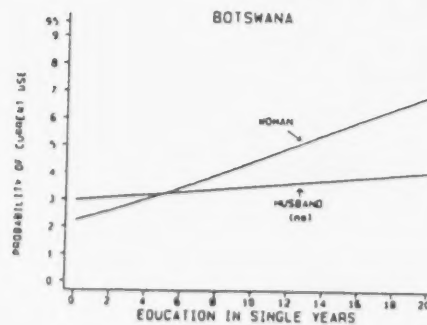
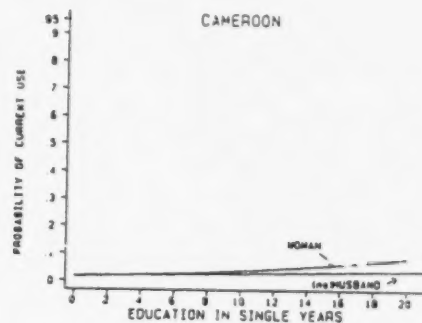
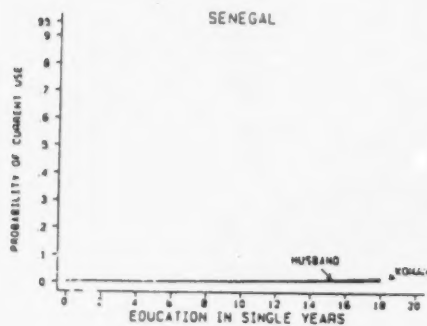
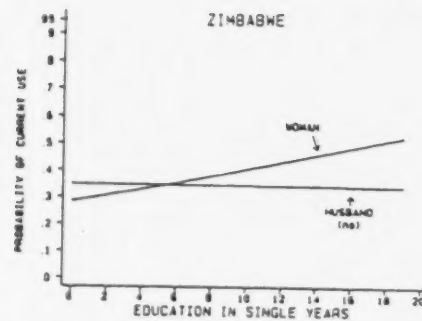
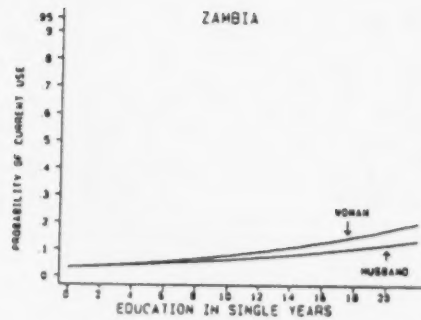


**TABLE 15: Marginal effect of raising female and male schooling by one year on current use of contraception (percentage points), sample of ever-married women and their partners**

| COUNTRY             | Female schooling                      |                                |                                |                                 | Male schooling                      |                              |                              |                               |
|---------------------|---------------------------------------|--------------------------------|--------------------------------|---------------------------------|-------------------------------------|------------------------------|------------------------------|-------------------------------|
|                     | At the mean level of female schooling | At 3 years of female schooling | At 6 years of female schooling | At 10 years of female schooling | At the mean level of male schooling | At 3 years of male schooling | At 6 years of male schooling | At 10 years of male schooling |
| Tanzania            | .43                                   | .40                            | .59                            | .96                             | .20                                 | .18                          | .21                          | .26                           |
| Uganda              | .12 <sup>a</sup>                      | .12                            | .15                            | .21                             | + ns                                | + ns                         | + ns                         | + ns                          |
| Burundi             | + ns                                  | + ns                           | + ns                           | + ns                            | + ns                                | + ns                         | + ns                         | + ns                          |
| Mali                | .02 <sup>a</sup>                      | .03                            | .04                            | .06                             | + ns                                | + ns                         | + ns                         | + ns                          |
| Niger               | .12                                   | .14                            | .16                            | .26                             | + ns                                | + ns                         | + ns                         | + ns                          |
| Nigeria             | .20                                   | .20                            | .26                            | .37                             | .17                                 | .16                          | .19                          | .22                           |
| Ondo State, Nigeria | .42                                   | .39                            | .61                            | 1.08                            | + ns                                | + ns                         | + ns                         | + ns                          |
| Kenya               | 1.11                                  | .99                            | 1.21                           | 1.52                            | .49                                 | .44                          | .48                          | .54                           |
| Ghana               | + ns                                  | + ns                           | + ns                           | + ns                            | + ns                                | + ns                         | + ns                         | + ns                          |
| Togo                | .18                                   | .20                            | .28                            | .42                             | .16                                 | .16                          | .21                          | .31                           |
| Zambia              | .43                                   | .37                            | .47                            | .64                             | .34                                 | .26                          | .32                          | .41                           |
| Zimbabwe            | 1.21                                  | 1.16                           | 1.23                           | 1.29                            | - ns                                | - ns                         | - ns                         | - ns                          |
| Senegal             | .03 <sup>a</sup>                      | .03                            | .04                            | .05                             | .04                                 | .05                          | .07                          | .10                           |
| Cameroon            | .23                                   | .21                            | .27                            | .39                             | + ns                                | + ns                         | + ns                         | + ns                          |
| Botswana            | 2.21                                  | 2.04                           | 2.28                           | 2.49                            | + ns                                | + ns                         | + ns                         | + ns                          |

a. Statistically significant at .05.

**TABLE 16: Relation between ownership of assets (income proxies) and contraceptive use**

| COUNTRY             | Radio          | Television     | Bicycle | Good Flooring |
|---------------------|----------------|----------------|---------|---------------|
| Tanzania            | + <sup>a</sup> | - ns           | - ns    | +             |
| Uganda              | + ns           | + ns           | + ns    | +             |
| Burundi             | + ns           | + ns           | - ns    | + ns          |
| Mali                | + <sup>a</sup> | + ns           | + ns    | + ns          |
| Niger               | + ns           | - ns           | - ns    | +             |
| Nigeria             | + <sup>a</sup> | +              | + ns    | + ns          |
| Ondo State, Nigeria | - ns           | + ns           | - ns    | + ns          |
| Kenya               | +              | + ns           | + ns    | +             |
| Ghana               | + ns           | + ns           | + ns    | + ns          |
| Togo                | + <sup>a</sup> | - ns           | + ns    | +             |
| Zambia              | + <sup>a</sup> | +              | + ns    | +             |
| Zimbabwe            | + ns           | + <sup>a</sup> | + ns    | +             |
| Senegal             | + <sup>a</sup> | + ns           | + ns    | + ns          |
| Cameroon            | + ns           | + <sup>a</sup> | - ns    | + ns          |
| Botswana            | + ns           | - ns           | - ns    | +             |

a. Statistically significant at .05.

## VII. Summary and conclusions

In this paper we have analyzed the relation between female schooling, fertility and use of modern contraception in fifteen data sets from fourteen African countries surveyed by the Demographic and Health Surveys. Total fertility levels are high in these countries — ranging from a low of 5.0 in Botswana to as much as 7.4 in Niger. Modern contraceptive use is below 10 percent in all but three countries (Kenya, Botswana, and Zimbabwe). These numbers reflect in part the high demand for children expressed by respondents in recent surveys — an "ideal family size" of 6 to 9 children (van de Walle and Foster 1990). Despite rising female enrollments in many countries, the level of completed schooling among women of reproductive age is extremely low. In six of the countries, half or more of all women have never been to school. Average levels of schooling are highest in Zimbabwe, with only six years of schooling; in four countries the average was less than two years.

Female schooling is posited to lead to demand for fewer children and to lower fertility through multiple channels: by raising the opportunity costs of women's time and thus the "price" of children; by raising the demand for child "quality"; by reducing child mortality; and by improving women's status. These same channels should induce a higher demand for modern contraception. In addition, women with more schooling can presumably learn about and use modern contraception more effectively than uneducated women.

The study has found strong support for the negative correlation between female schooling and fertility in virtually all of the countries. The overall relationship between women's schooling and cumulative fertility is negative in all countries, in both urban and rural areas. However, the relationship is non-linear. Primary schooling (including incomplete primary) has a negative relation with fertility in about half of the countries and no relation in the other half. Secondary schooling is universally associated with lower fertility and the negative association increases as the level of schooling rises.<sup>29</sup> This is true even in countries with less vigorous family planning programs. The size of the education effects on fertility varies a great deal across countries, but the reasons for these differences remain obscure. No major differences between countries in different income groups have been noted, but the study found evidence of a *positive* relation between proxies for wealth and fertility in Nigeria (holding schooling constant) and a negative relation in Tanzania, Ghana, Togo, and Botswana.<sup>30</sup> In restricted samples of ever-married women, husband's schooling has no significant relation with fertility in about one-third of the countries and where both women's and men's schooling matter, women's schooling exerts a much larger negative effect on fertility than men's schooling. The analysis also confirmed that female schooling effects are lower when the samples are restricted to

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29. Jejeeboy (1992), reviewing the evidence on education and fertility primarily from the World Fertility Survey (WFS), characterized the evidence for "a uniformly inverse relationship" in the poorest countries as "shaky": "a little education appears to lead to higher fertility and we are likely observe a curvilinear or reversed U-shaped relationship" (p. 3). In fact, she points to an "inverted U" shape in ten of twelve African countries, implying that at low levels of schooling fertility rises. However, this study, which uses different and more recent data sets, controls for many more factors simultaneously (including wealth) and is based on microanalysis of actual fertility (as opposed to the TFR), finds very limited evidence of a positive effect of schooling on fertility in these countries (in one country only with very low levels of schooling and in one age cohort).

30. Jejeeboy (1992) found that inverse relationships between women's education and fertility are more likely to occur at later stages of development. However, we were unable to detect any patterns across countries when grouped by GNP per capita.

ever-married women. This means that studies that are based on married women understate the effects of schooling on fertility and contraceptive use.

Female schooling has also been found to greatly raise the likelihood of contraceptive use, even among women with primary schooling only. However, as with fertility, the relation is nonlinear. Schooling induces an increasing propensity to use contraception with higher levels. Among ever-married women, husband's schooling is associated with higher contraceptive use in only six of the fifteen data sets and in cases where men's schooling is statistically significant, it generally exerts a smaller effect than women's schooling.

This study has used multivariate analysis of cross-sectional data to examine "marginal" relationships — such as the effect in the cross-section of altering schooling by a small amount. However, the levels of female schooling in these countries are so low that more than just marginal increases in female schooling will be necessary. The multivariate regression results do not help us to infer the likely impact of large changes in female schooling — like ensuring that 40 percent of women with no schooling complete seven years of primary education. The effect of such a large change will be under-estimated by a regression coefficient. Further, other factors held constant in these regressions — like income — might also change as a result of large increases in schooling. However, the experience of countries like Kenya, Botswana, and Zimbabwe — where major investments in schooling and family planning have been made in the past decade — is indicative of the likely effect of similar policies in other countries. The impact of these investments is not limited to fertility reduction but will improve the quality of life for women and children and enhance their future contribution to development.

While the results confirm the persistent and robust effects of female education across countries, there are marked differences in the size of these effects across countries that have not been explained. The analysis simultaneously controlled for exogenous factors like age, urban residence, region, religion, ethnicity, and ownership of durable goods (proxies for wealth). The absolute levels of female schooling are low in all countries, but the greatest "success" has been achieved in countries that have made major investments in female secondary schooling. However, increasing the share of women who complete primary schooling should also lower fertility and raise contraceptive use, while simultaneously improving the status and opportunities of women. An important factor that we have not been able to control for is the availability and price of family planning services, which surely affects contraceptive use, if not fertility. Further, because of a lack of data, we have not been able to examine the potential complementarity between schooling and family planning services. Scribner (1994) has characterized the population policies of most of the countries in this study, including those on family planning, child health, women's legal status, and family planning. Progress on all of these fronts will be necessary to simultaneously lower the demand for children and improve the "quality" of human resources in Sub-Saharan Africa.

# ANNEX 1:

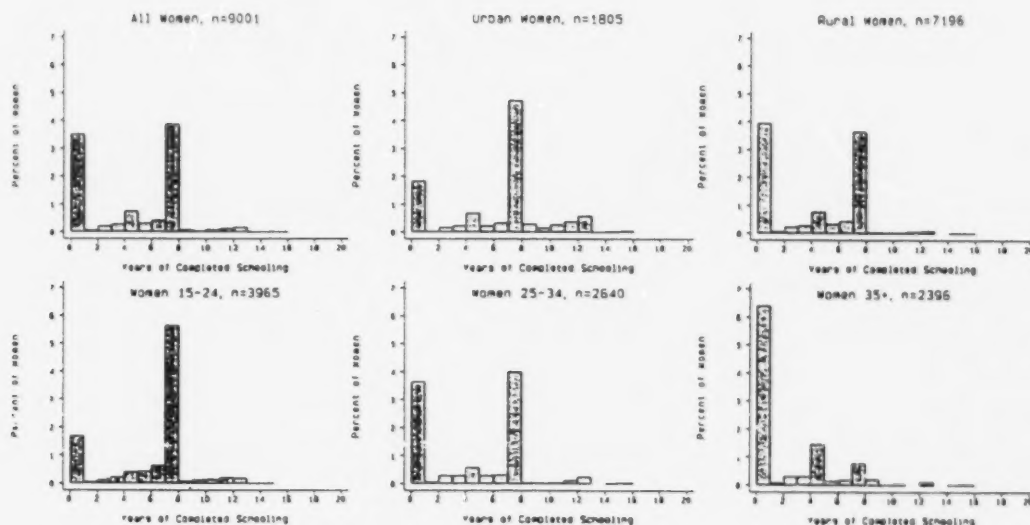
## Notes on sampling and coverage of DHS data sets

| DATA SET            | OVER-SAMPLING/WEIGHTING                                                                                                                                           | COVERAGE                                                                                                                                                                                |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Botswana            | Over-sampling of urban areas by a factor of 2. Self-weighted sample within urban and rural areas.                                                                 | National                                                                                                                                                                                |
| Burundi             | Over-sampling of urban areas by a factor of 5. Self-weighted within urban and rural areas.                                                                        | National                                                                                                                                                                                |
| Cameroon            | Yaoundé/Douala over-sampled by a factor of 2. Other urban areas also over-sampled. Self-weighted sample within each urban and rural stratum.                      | National                                                                                                                                                                                |
| Ghana               | No over-sampling. Self-weighted.                                                                                                                                  | National                                                                                                                                                                                |
| Kenya               | Stratification and different weights for urban and rural areas and each district.                                                                                 | Excludes North Eastern province and 4 northern districts accounting for 5% of the national population.                                                                                  |
| Mali                | Over-sampled urban areas. Self-weighted within urban and rural strata.                                                                                            | 100% coverage of urban areas; 90-95% coverage of rural areas. Nomadic rural population of Timubuktu and Gao excluded.                                                                   |
| Niger               | Oversampled Niamey by a factor of 4 and other urban areas by a factor of 3, relative to rural areas.                                                              | All departments except pastoral areas of northern desert (zone of Arlit in the Agadez department, arrondissement of Bilma). Excluded population is less than 1% of national population. |
| Nigeria             | Oversampled urban areas by a factor of 2. Self-weighted sample within urban and rural strata.                                                                     | National                                                                                                                                                                                |
| Ondo State, Nigeria | No over-sampling. Self-weighted.                                                                                                                                  | State                                                                                                                                                                                   |
| Senegal             | No over-sampling. Self-weighted.                                                                                                                                  | National                                                                                                                                                                                |
| Tanzania            | Stratified by urban/rural area and by region; different weights apply to each region and urban/rural areas.                                                       | National (Mainland and Zanzibar)                                                                                                                                                        |
| Togo                | No over-sampling. Self-weighted.                                                                                                                                  | National                                                                                                                                                                                |
| Uganda              | Urban areas over-sampled by a factor of 3. Self-weighted within urban areas. South West region and Luwero Triangle in Central Region over-sampled in rural areas. | Excludes 9 of 34 districts, with 20% of the national population.                                                                                                                        |
| Zambia              | Over-sampling of Luapula, North-Western and Western provinces.                                                                                                    | National                                                                                                                                                                                |
| Zimbabwe            | No over-sampling. Self-weighted.                                                                                                                                  | National                                                                                                                                                                                |

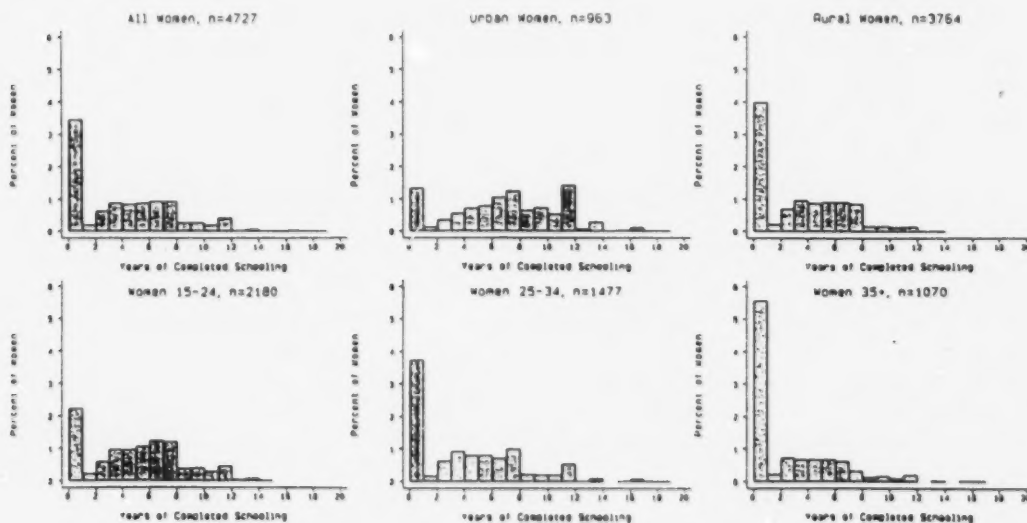
## ANNEX 2:

### Distribution of women by schooling in the 15 Sub-Saharan DHS data sets

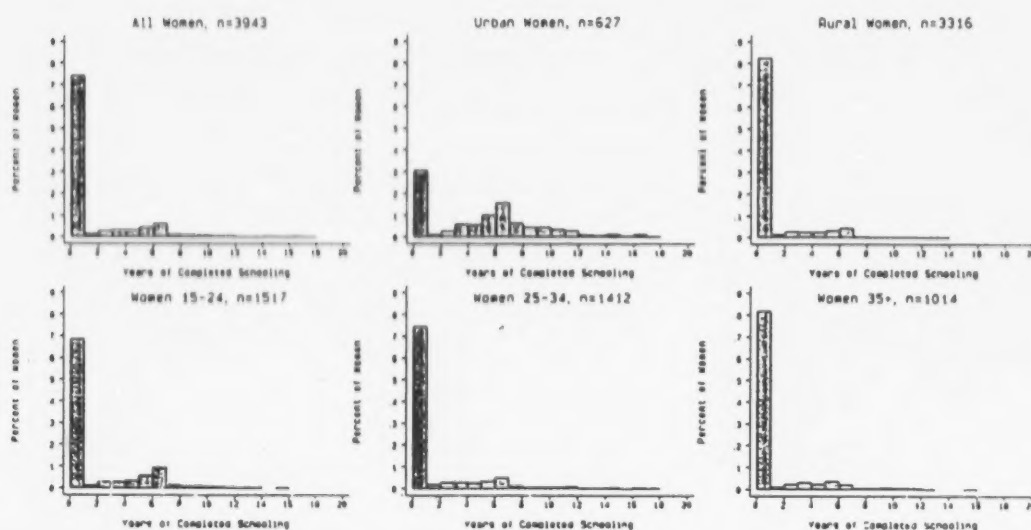
#### Distribution of Women by Schooling: Tanzania DHS 1991/92



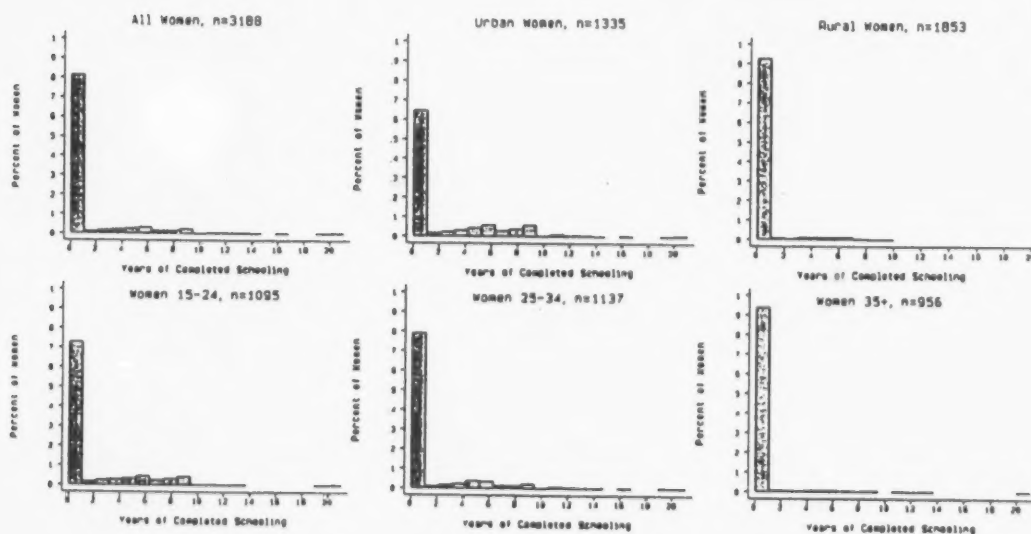
#### Distribution of Women by Schooling: Uganda DHS, 1988/89



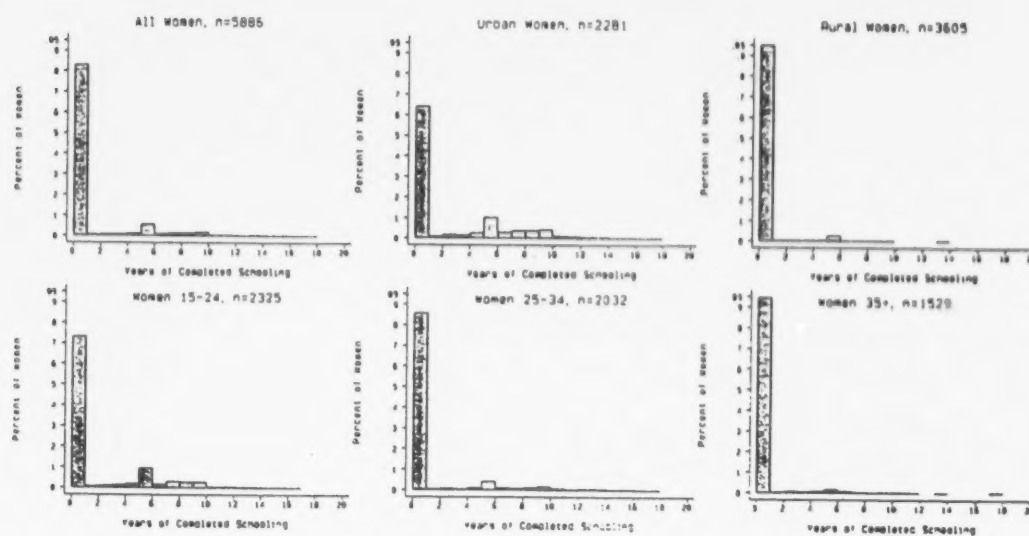
# Distribution of Women by Schooling: Burundi DHS, 1987



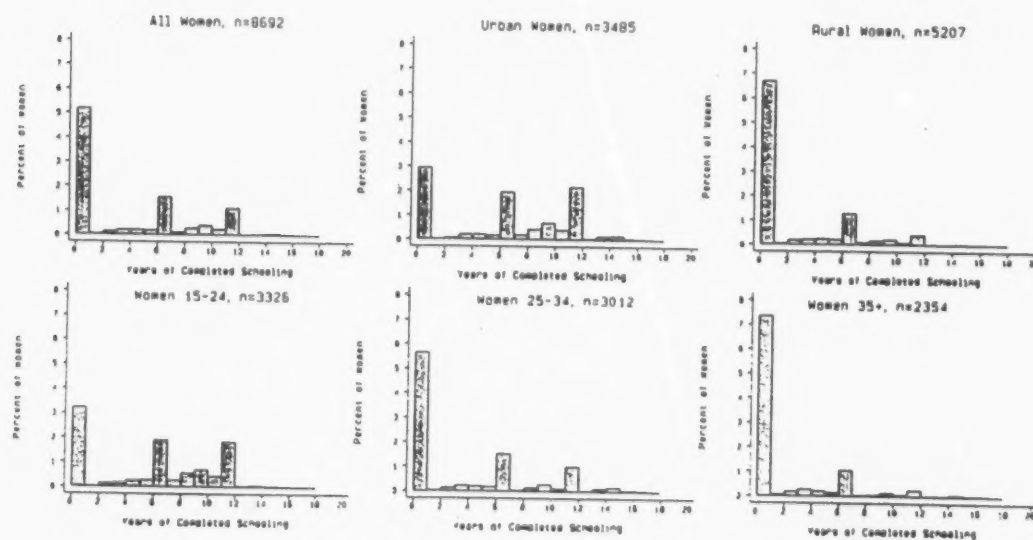
# Distribution of Women by Schooling: Mali DHS, 1987



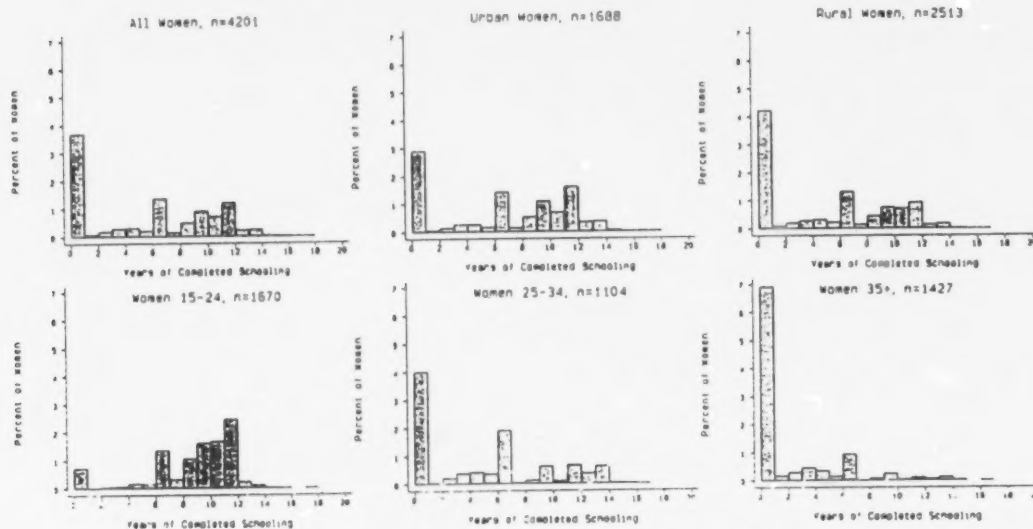
## Distribution of Women by Schooling: Niger DHS, 1993



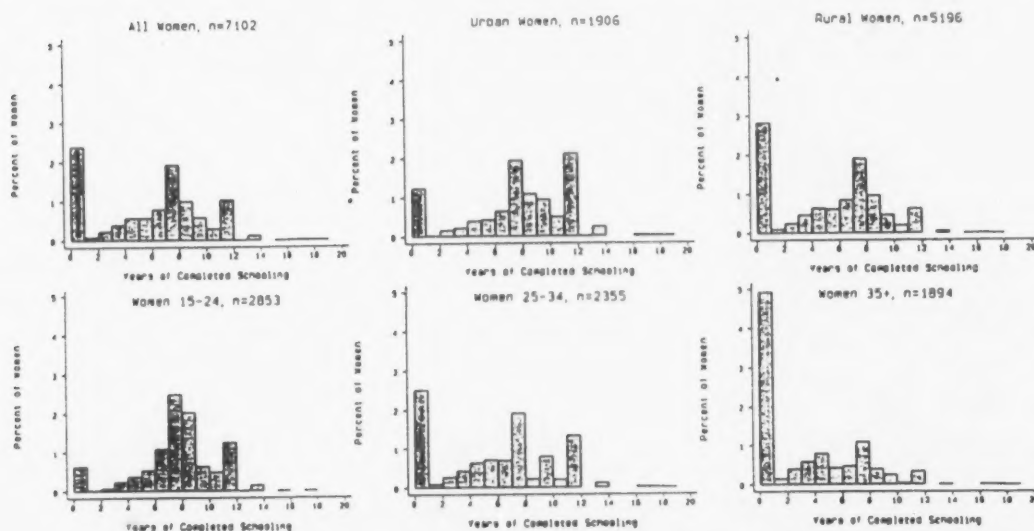
## Distribution of Women by Schooling: Nigeria DHS 1990



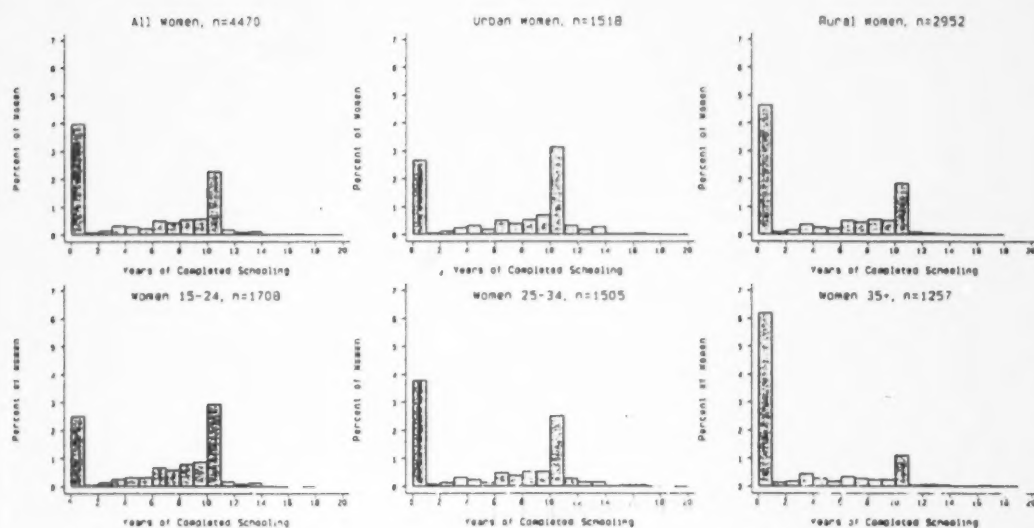
# Distribution of Women by Schooling: Ondo State DHS 1986/87



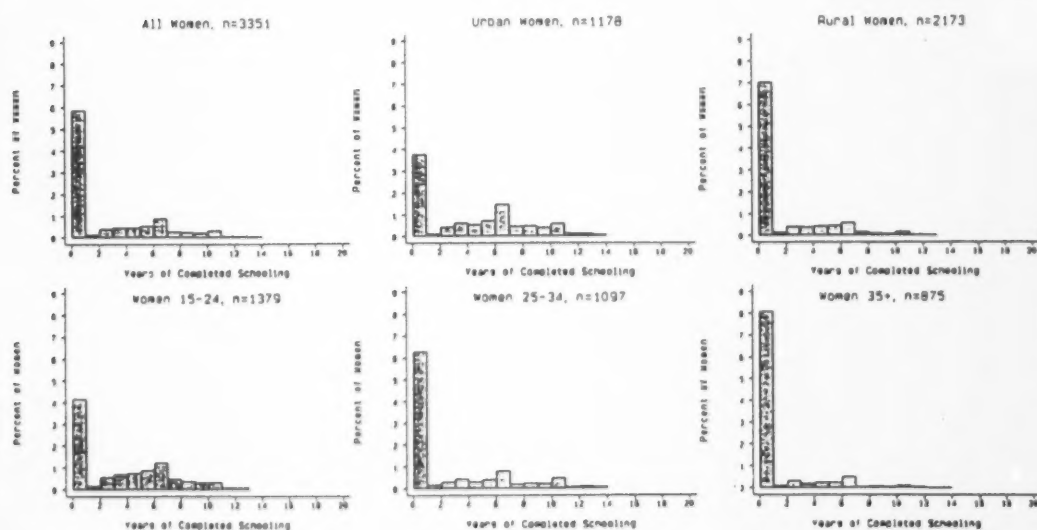
# Distribution of Women by Schooling: Kenya DHS 1988/89



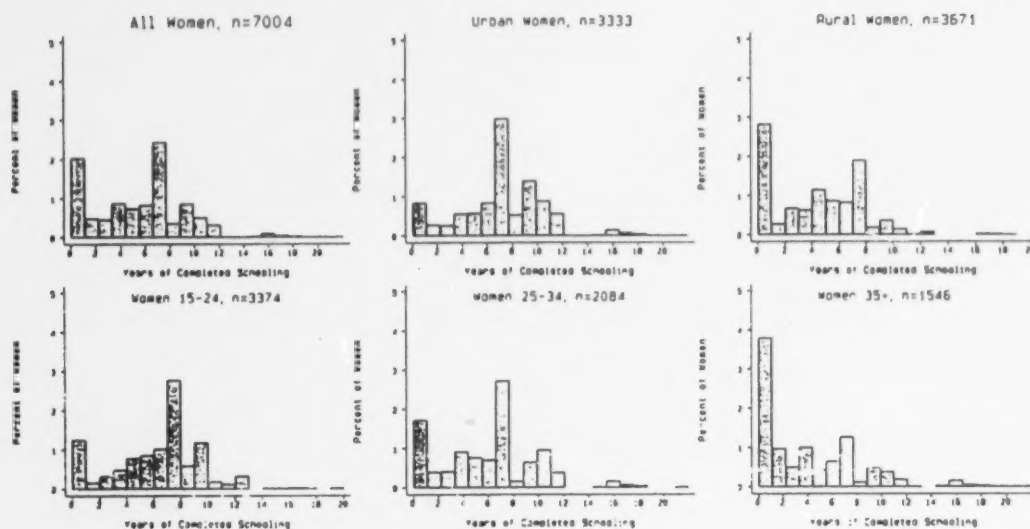
## Distribution of Women by Schooling: Ghana DHS, 1988



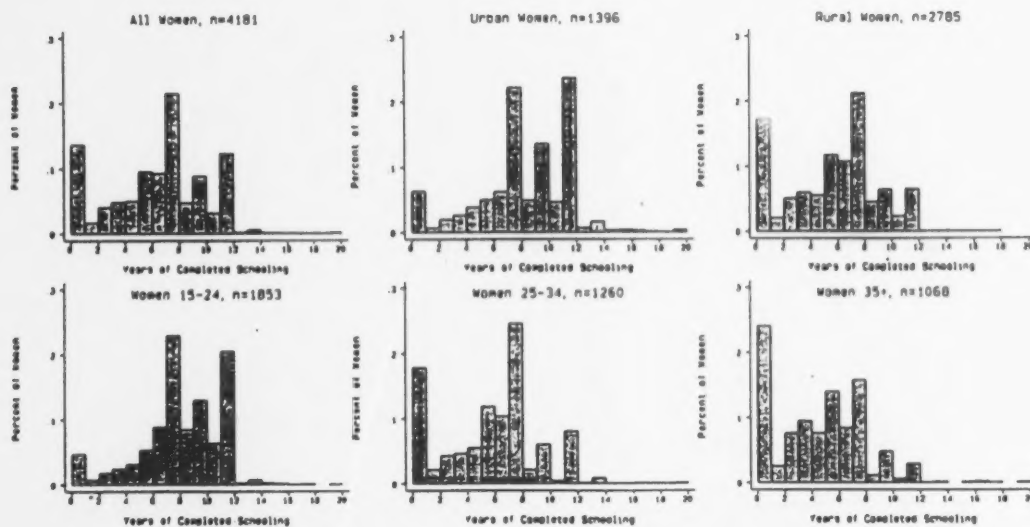
## Distribution of Women by Schooling: Togo DHS, 1989



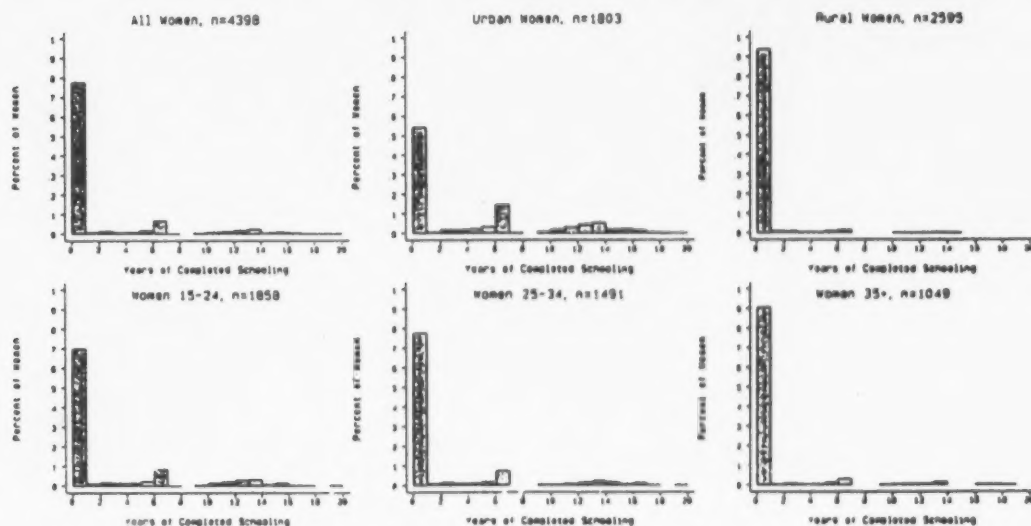
## Distribution of Women by Schooling: Zambia DHS, 1992



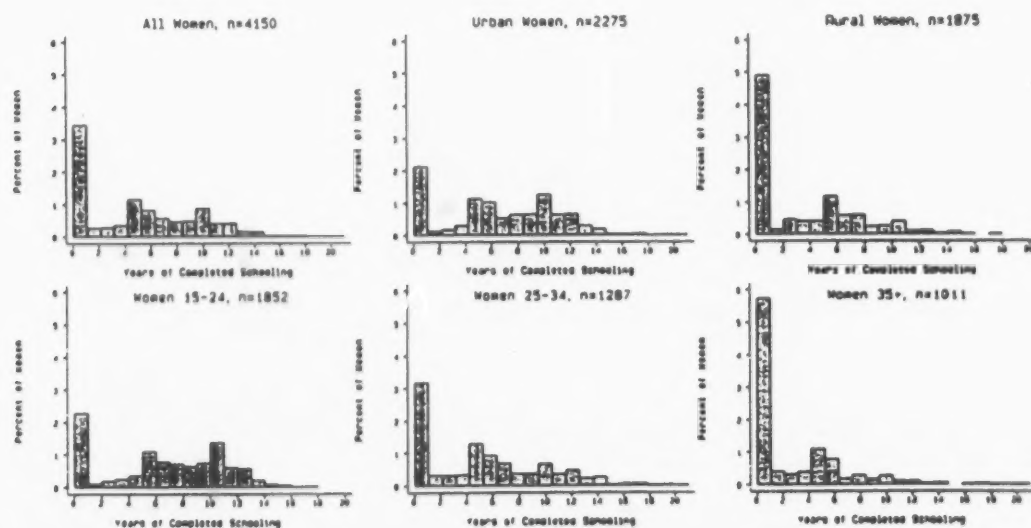
## Distribution of Women by Schooling: Zimbabwe DHS, 1988/89



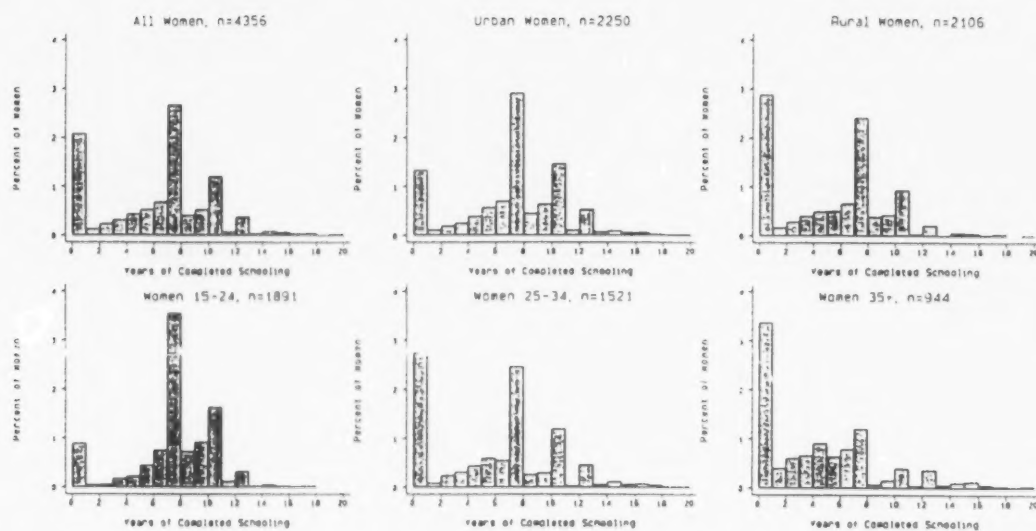
# Distribution of Women by Schooling: Senegal DHS, 1986



# Distribution of Women by Schooling: Cameroon DHS, 1991



# Distribution of Women by Schooling: Botswana DHS, 1988



## ANNEX 3:

## Marginal effects of raising female schooling on contraceptive use

TABLE A3.1: Marginal effect of raising female schooling  
by one year on ever use of contraception (percentage points)

| <i>COUNTRY</i>      | <i>At the mean<br/>level of female<br/>schooling</i> | <i>At 3 years of<br/>female<br/>schooling</i> | <i>At 6 years of<br/>female<br/>schooling</i> | <i>At 10 years of<br/>female<br/>schooling</i> |
|---------------------|------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|------------------------------------------------|
| Tanzania            | .98                                                  | .83                                           | 1.26                                          | 2.04                                           |
| Uganda              | .86                                                  | .76                                           | 1.31                                          | 2.52                                           |
| Burundi             | .12                                                  | .14                                           | .18                                           | .25                                            |
| Mali                | .18                                                  | .24                                           | .40                                           | .78                                            |
| Niger               | .16                                                  | .17                                           | .19                                           | 2.26                                           |
| Nigeria             | 1.09                                                 | .98                                           | 1.54                                          | 2.60                                           |
| Ondo State, Nigeria | 1.68                                                 | 1.10                                          | 1.99                                          | 3.78                                           |
| Kenya               | 1.76                                                 | 1.47                                          | 1.83                                          | 2.31                                           |
| Ghana               | 1.53                                                 | 1.31                                          | 1.68                                          | 2.21                                           |
| Togo                | 1.10                                                 | 1.21                                          | 1.80                                          | 2.80                                           |
| Zambia              | 2.24                                                 | 1.70                                          | 2.40                                          | 3.40                                           |
| Zimbabwe            | .78                                                  | .78                                           | .78                                           | .79                                            |
| Senegal             | .23                                                  | .28                                           | .45                                           | .83                                            |
| Cameroon            | 2.06                                                 | 1.48                                          | 2.37                                          | 3.88                                           |
| Botswana            | 3.71                                                 | 3.81                                          | 3.70                                          | 3.04                                           |

**TABLE A3.2: Marginal effect of raising female schooling by one year on ever use of contraception (percentage points), urban and rural samples**

| URBAN               |                                              |                                       |                                       |                                        |
|---------------------|----------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|
| <i>COUNTRY</i>      | <i>At the mean level of female schooling</i> | <i>At 3 years of female schooling</i> | <i>At 6 years of female schooling</i> | <i>At 10 years of female schooling</i> |
| Tanzania            | 1.91                                         | 1.45                                  | 1.93                                  | 2.61                                   |
| Uganda              | 3.18                                         | 2.27                                  | 3.08                                  | 3.97                                   |
| Mali                | 1.23                                         | 1.33                                  | 2.01                                  | 3.16                                   |
| Niger               | .76                                          | .77                                   | .84                                   | .94                                    |
| Nigeria             | 2.22                                         | 1.57                                  | 2.21                                  | 3.16                                   |
| Ondo State, Nigeria | 2.10                                         | 1.27                                  | 2.07                                  | 3.53                                   |
| Kenya               | 2.23                                         | 1.80                                  | 2.11                                  | 2.46                                   |
| Ghana               | 1.94                                         | 1.54                                  | 1.89                                  | 2.34                                   |
| Togo                | 2.49                                         | 2.20                                  | 3.25                                  | 4.53                                   |
| Zambia              | 3.37                                         | 2.28                                  | 3.11                                  | 4.03                                   |
| Zimbabwe            | .47                                          | .47                                   | .47                                   | .47                                    |
| Senegal             | 1.14                                         | .99                                   | 1.53                                  | 2.51                                   |
| Cameroon            | 3.04                                         | 2.02                                  | 2.85                                  | 3.89                                   |
| Botswana            | 3.30                                         | 3.65                                  | 3.40                                  | 2.70                                   |

| RURAL               |                                              |                                       |                                       |                                        |
|---------------------|----------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|
| <i>COUNTRY</i>      | <i>At the mean level of female schooling</i> | <i>At 3 years of female schooling</i> | <i>At 6 years of female schooling</i> | <i>At 10 years of female schooling</i> |
| Tanzania            | .79                                          | .71                                   | 1.11                                  | 1.91                                   |
| Nigeria             | .58                                          | .68                                   | 1.17                                  | 2.23                                   |
| Ondo State, Nigeria | 1.40                                         | .99                                   | 1.97                                  | 4.19                                   |
| Kenya               | 1.54                                         | 1.33                                  | 1.69                                  | 2.19                                   |
| Ghana               | 1.23                                         | 1.11                                  | 1.45                                  | 1.97                                   |
| Zambia              | 1.38                                         | 1.24                                  | 1.77                                  | 2.62                                   |
| Zimbabwe            | .81                                          | .80                                   | .82                                   | .83                                    |
| Botswana            | 3.91                                         | 3.82                                  | 3.88                                  | 3.35                                   |

**TABLE A3.3: Marginal effect of raising female and male schooling by one year on ever use of contraception (percentage points)**

| <i>Country</i>      | <i>At the mean level of female schooling</i> | <i>At 3 years of female schooling</i> | <i>At 6 years of female schooling</i> | <i>At 10 years of female schooling</i> | <i>At the mean level of male schooling</i> | <i>At 3 years of male schooling</i> | <i>At 6 years of male schooling</i> | <i>At 10 years of male schooling</i> |
|---------------------|----------------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|--------------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|
| Tanzania            | 1.02                                         | .96                                   | 1.34                                  | 1.97                                   | .65                                        | .57                                 | .71                                 | .93                                  |
| Uganda              | .72                                          | .70                                   | 1.08                                  | 1.83                                   | .51                                        | .37                                 | .52                                 | .78                                  |
| Burundi             | + ns                                         | + ns                                  | + ns                                  | + ns                                   | .17                                        | .18                                 | .23                                 | .32                                  |
| Mali                | .15                                          | .21                                   | .35                                   | .65                                    | .06                                        | .07                                 | .08                                 | .10                                  |
| Niger               | .17                                          | .19                                   | .21                                   | .29                                    | .13                                        | .14                                 | .16                                 | .21                                  |
| Nigeria             | .69                                          | .72                                   | .98                                   | 1.42                                   | .44                                        | .41                                 | .50                                 | .65                                  |
| Ondo State, Nigeria | 1.02                                         | .96                                   | 1.45                                  | 2.33                                   | .43                                        | .38                                 | .46                                 | .58                                  |
| Kenya               | 2.14                                         | 1.95                                  | 2.26                                  | 2.57                                   | 1.22                                       | 1.08                                | 1.19                                | 1.32                                 |
| Ghana               | 1.35                                         | 1.25                                  | 1.48                                  | 1.79                                   | .90                                        | .77                                 | .87                                 | 1.01                                 |
| Togo                | .77                                          | .88                                   | 1.21                                  | 1.78                                   | .57                                        | .53                                 | .68                                 | .94                                  |
| Zambia              | 2.20                                         | 1.88                                  | 2.36                                  | 2.91                                   | 1.37                                       | 1.12                                | 1.30                                | 1.54                                 |
| Zimbabwe            | 1.51                                         | 1.59                                  | 1.49                                  | 1.33                                   | + ns                                       | + ns                                | + ns                                | + ns                                 |
| Senegal             | .11                                          | .13                                   | .18                                   | .26                                    | .14                                        | .18                                 | .27                                 | .43                                  |
| Cameroon            | 1.36                                         | 1.17                                  | 1.69                                  | 2.54                                   | .87                                        | .70                                 | .90                                 | 1.20                                 |
| Botswana            | 2.80                                         | 2.99                                  | 2.69                                  | 2.13                                   | .95                                        | .98                                 | .94                                 | .88                                  |

Figure A3: Predicted ever use of contraception according to female and male schooling, sample of ever-married women

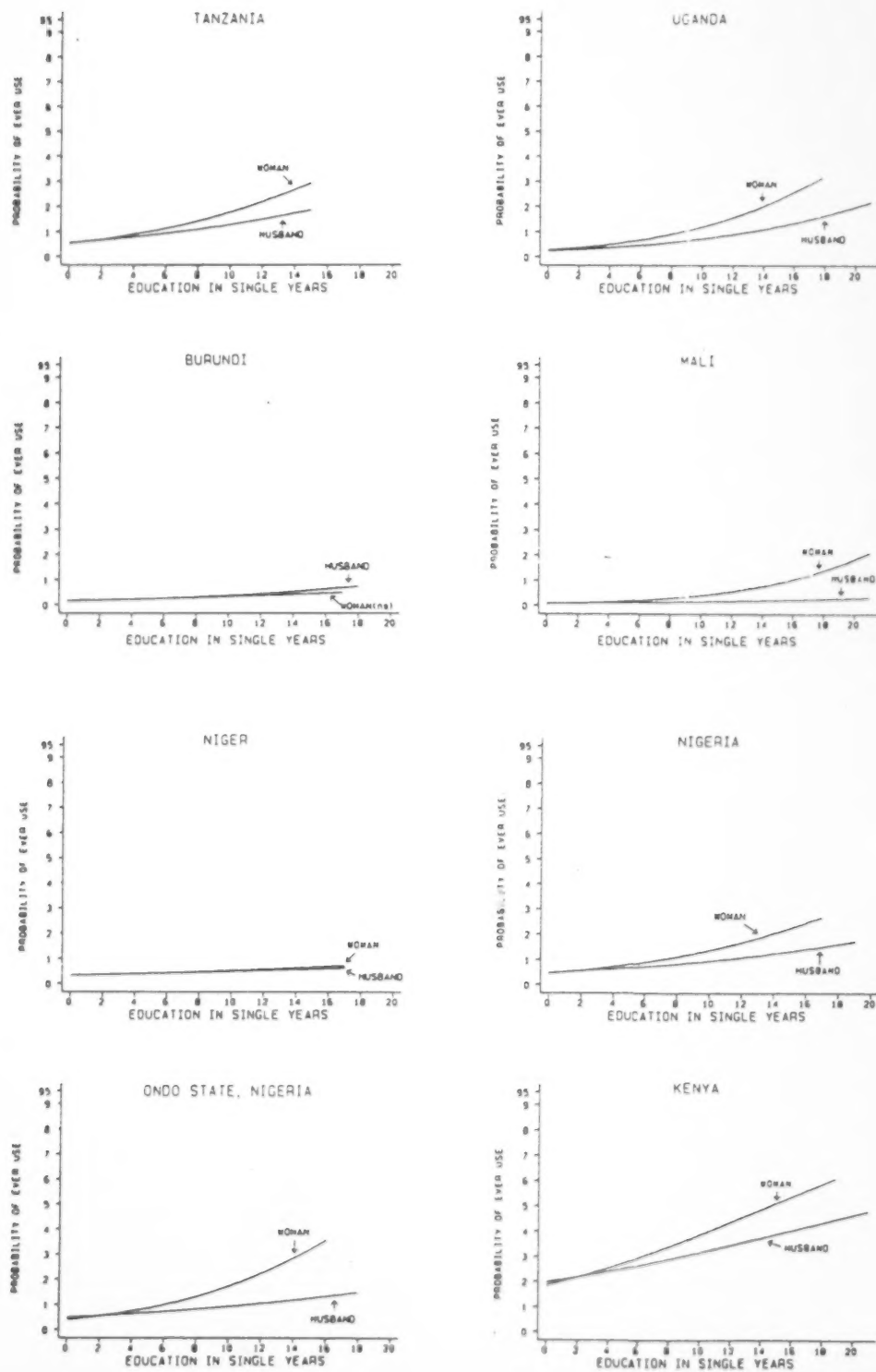
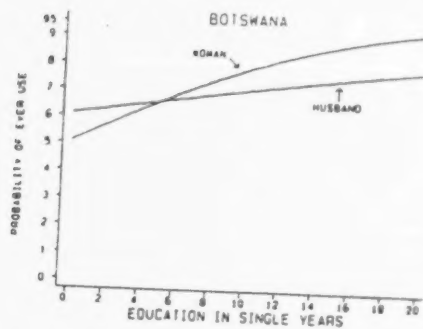
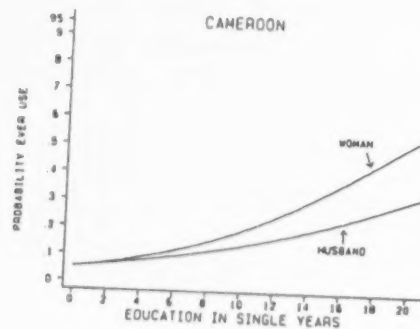
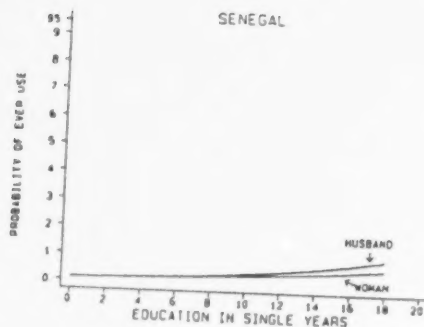
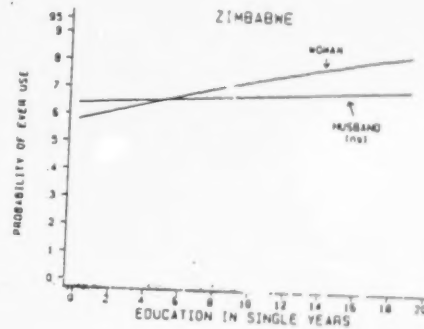
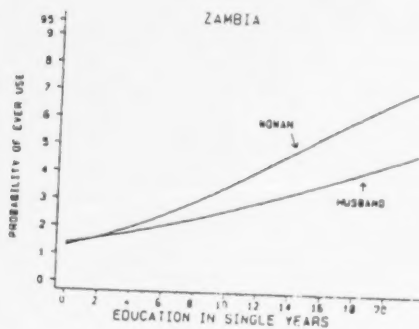
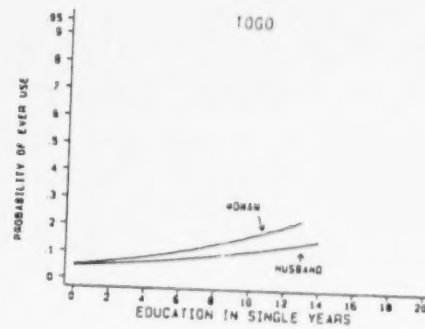
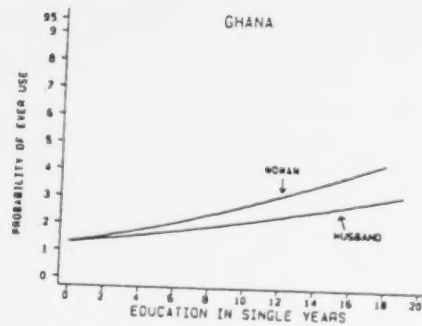


Figure A3 continued



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